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A NATURALIST'S HOLIDAY BY THE SEA

To my son

ARTHUR MESNY DE CARLE

*this book is lovingly dedicated, in memory of a
delightful holiday, and in the hopes that it will
help to guide his feet in the pleasurable paths of
Biological research, that, by reason of his heritage,
seem to lie before him.*



(Photo by Gibson & Sons: Penzance.)

Where sea, land, and air meet always the most fecund place for the evolution of new animal
and plant forms.

A Naturalist's Holiday by the Sea

BEING A COLLECTION OF ESSAYS ON THE MARINE,
LITTORAL, AND SHORE-LAND LIFE OF THE CORNISH
PENINSULA INCLUDING SHORT ACCOUNTS OF THE
MINERALOGY AND GEOLOGY, AS WELL AS OF SOME
OF THE BIRDS OF THE INTERIOR.

BY

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WITH NUMEROUS ILLUSTRATIONS IN THE TEXT

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" The World below the brine,
Forests at the bottom of the sea—the branches and leaves,
Sea-lettuce, vast lichens, strange flowers and seeds—the thick
tangle, the openings, the pink turf,
Different colours, pale grey and green, purple, white and gold—
the play of light through water,
Dumb swimmers there among the rocks—coral, gluten, grass,
rushes—and the aliment of the swimmers,
Sluggish existences grazing there, suspended, or slowly crawling
close to the bottom ;
The sperm-whale at the surface, blowing air and spray, or
disporting with his flukes,
The leaden-eyed shark, the walrus, the turtle, the hairy sea-
leopard, and the sting ray.
Passions there, wars, pursuits, tribes—sight in those ocean
depths—breathing that thick breathing air, as so
many do."

—WALT WHITMAN

PREFACE

THE present volume is the outcome of a summer holiday in Cornwall with Penzance as headquarters. It deals mainly with objects of biological interest belonging to the foreshore, and is meant for the general reader and those holiday makers who find in the animal and plant life of the sea-washed rocks, the open beaches, and the inshore waters a subject worthy of their study, who wish to know the names of the creatures they may find there, and something of their life histories.

It is not pretended that the account contained herein is in any way exhaustive, but, since, in one way and another, most of the main branches of living organisms that throng the sea coast are dealt with, it is hoped that it may serve as an introduction to the general subject of coastal and marine biology, than which few more fascinating exist.

The life of the winding strip of coastline—if by the latter is meant a belt extending in width from, and including, the cliffs to the edge of what is known as the “Continental Shelf,” where the shallow waters end and the ocean depths begin—is probably by far the richest that exists on the face of the globe, not only in numbers of individuals, but in species, genera, families, and orders; and so this zone forms a very good laboratory for the commencement of the study of both animal and plant life. Indeed, it was just in this area that life on the earth, as we know it, probably began, while it is here, more than anywhere else, that we may expect to find—in fact, do find—new forms in the making. It was from this zone that both terrestrial plants and animals originated, and it is now evident that the fauna of the greatest ocean depths also spread from it to their present habitats in no very distant times.

In this zone may be found representatives of every class of animal and plant life, from the very lowest unicellular organisms to the highest and most complex, so that here may be seen, better than in any other life-zone, and in a more complete state, the ladder of Evolution from the smallest and most primitive beings to the greatest and most specialized.

The study of biology in its widest sense is of paramount importance to the human race, since in it lie hidden all the treads that will ultimately lead man to a solution of "the riddle of the Universe." Life is the greatest and most important of all the phenomena that man does not understand. It is the one, above all others, that his whole being, individually and collectively, is clamouring to comprehend, and whose mystery, it is obvious, he can only hope to solve in time by means of the study of living organisms. One is reminded of Browning's words :—

" Many a thrill
Of kinship, I confess to, with the powers
Called Nature; animate, inanimate,
In parts or in the whole, there's something there
Man-like, that somehow meets the man in me."

Nature is man-like: man is part of Nature; and, if we are to understand man and all he stands for, it is evident that first we must understand Nature, and, above all, the world of living things.

In these days there are many who presume to dispute, scoff at, ridicule what they are pleased to call the "dogmas of science." Darwin, whose genius first perceived—or at least dared to give expression to—the truth that made it possible for his followers to understand how the animals and plants we see around us to-day came into being, who showed the existence of an ordered evolution in Nature's workshop, who gave us the key to the riddle that had baffled mankind from the days of Aristotle to the middle of the Nineteenth Century—Darwin and his followers they hold up to scorn. Blind and ignorant, they say he has been proved a false prophet, when, as a matter of fact, never were the theories he propounded believed, in the main, more firmly by naturalists and men of science than to-day. These scoffers simply do not know their Natural History. They are floundering in a sea of ignorance of the commonest facts of biology. They, and not Darwin, are the false prophets that endeavour to lead astray the minds of the general public.

Huxley, who fought with all the force of his ardent nature to convince a benighted world, a world of bitter and fanatical antagonism, of the truth that Darwin had hit upon, encountered such men, and, since they are rampant again, the rebuke he gave them may be quoted. Speaking of the complete failure of his opponents to grasp what to him, and all true naturalists, was so clear, he says :—

" Notwithstanding this discouraging result, I venture, as a parting word, to repeat the suggestion, and to say to all the more or less acute lay and clerical 'paper philosophers' who venture into the regions of biological controversy—Get a little sound, thorough, practical, elementary instruction in Biology."

And to-day this suggestion may well be put forward again, not merely to the "paper philosophers" who venture into the regions of biological controversy, but to the whole reading public, for, whatever else may come of it, of one thing they may rest assured, and that is that their own lives will be immeasurably enriched by a sound knowledge of the lives, forms, habits, and structure of the plants and animals they encounter as they go about their daily affairs, and, when the time comes for their annual vacation in the country, or by the sea, vistas of unending delight will open out before them.

If this book helps any along the road to a good, working knowledge of Natural History, then is its purpose well served.

In gathering together the material upon which it is based, I was continually accompanied and assisted by my wife and small son, aged ten, who displays in all his doings a keen interest in animals, living and dead, in plants, but most of all in minerals and fossils ; and in some ways the book is an account of the biological experiences of the three of us, as we toured the country round Penzance, picnicked in the woods or on the rocks ; hunted the sandy beaches ; explored the cliffs and quarries ; or went fishing on the pier, or out in the bay. Every minute of our time was taken up, and, it will be seen, our endeavours were amply rewarded by all that we saw and found.

As it would be manifestly impossible in a volume of this compass to deal with all the many forms belonging to each of the numerous classes of animals that are to be found along such a coastline as that of Cornwall, the method pursued in writing it has been to discuss the subject with the species we actually collected or encountered as a basis, describing them more or less briefly, and referring, only, to some of their near relatives that have been recorded from the county.

This brings us to a feature of this book upon which a certain amount of criticism may be anticipated, but which, if explained at the outset, may save some would-be readers from glancing through its pages, and, discouraged by the sight of long, technical names, casting it aside unread. Everywhere the first mention of

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the popular name of any plant or animal has been followed by its scientific name in italics and bracketted, together with the abbreviated name of the original authority for it, e.g., Linn. for Linnaeus or Linnaeus, and Müll for Müller. The reason for this is a desire to avoid any doubt as to exactly what species is being discussed. Popular names are often so vague and unreliable that serious writers and the authors of technical biological works generally dispense with them altogether, with the result that to all, save the initiated, their books and papers are unintelligible. But if to the popular name the true scientific equivalent is added, there can be no doubt as to precisely which species is meant, and this cannot but increase the value of such remarks as may be passed by the writer. Further, it will assist the beginner, not only by giving him the correct scientific names of the animals and plants he is studying, but by furnishing him with a key to the further study of those species in the more technical literature he will find at his disposal, wherein popular names are seldom given.

The indulgence, therefore, is craved of those readers to whom scientific names are anathema, for the sake of those who may find them helpful. To the former it may be pointed out that, if they find these Latin names troublesome in their reading, they may easily overcome the difficulty by ignoring them: though in a few cases their inclusion will be found essential to a clear understanding of the text. In every case where they are enclosed in brackets they can be safely dispensed with. To those who ask "Then why not leave them out?" the reply is that no one can really get to know much about Nature's many creatures unless he learns their names, and since the same creature may be known by different popular names in different parts of the country, or two different creatures in different parts of the country by the same name, it follows that the only really reliable name is the scientific one; so, the sooner he becomes familiar with the latter the better.

Great care has been exercised in determining the species of the animals and plants dealt with in the following pages, and in this connection I am indebted to certain of the assistant curators at the British Museum of Natural History, South Kensington, notably of the departments of fishes and cryptogamic plants, for verifying the names assigned. For the rest, such literature as is extant, and particularly that monument of information, the volume of "The Victoria History of the Counties of England" devoted to

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Cornwall, has rendered the determinations of the species of birds, molluscs, crustaceans, and other low forms of animal life that were seen and collected by us a comparatively easy task.

It must not be taken for granted that, because the subject matter of this book is based on Cornish animals and marine plants, it can have no bearing upon the coastal Natural History of other parts of the country. Such is far from being the case. Most of the species mentioned are to be found all along the south coast of England, many well up the eastern and western coasts, and not a few on all our shores. A few of the forms are purely Cornish as regards these islands, and they seem to be mainly stragglers of comparatively rare occurrence from the tropical waters of the Atlantic or from the region of the Mediterranean. The Cornish coastal fauna and flora happen to be particularly rich, and so form an excellent basis for a book of this nature. The only forms of marine plants and animals, that occur in other parts of our coasts, but are conspicuously absent from the region of the Cornish Peninsula, are the more or less boreal species, but even of these a good many have been recorded as stragglers.

For the photographic illustrations I am mainly indebted to Messrs Gibson and Sons, of the Mount's Bay Studio, Penzance. An accident to my own camera after the first dozen plates had been exposed prevented the photographing of fresh specimens of plants and animals, and on this account recourse has had to be made to somewhat rough sketches, which, however, it is hoped will help the would-be student and collector to identify some of the creatures he may discover on his next holiday by the sea.

ARTHUR DE CARLE SOWERBY.

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A Naturalist's Holiday by the Sea

CHAPTER I LIFE OF THE ROCK POOLS

"On some thick beds of mossy verdure grew
Sea grass, and spreading wrack are seen ; below
Gay Rainbow-fish, and sable Wrasse resort."—*Oppian.*

To any one who has a penchant for nature-study the rocks of a coast such as that of the Cornish Riviera most inevitably prove of irresistible attraction. At least my small son and I found it so, when we visited that delightful county on our annual summer holiday. Scarcely had we been twenty-four hours in Penzance, which we made our headquarters, before we had taken a rapid preliminary survey of the various rock clusters that the receding tide leaves bare every few hours, the rugged fringes, so to speak, of Neptune's kingdom, which we had come to explore.

And of all that world of wave-sculptured granite and slate, barnacle encrusted boulders, bladder-wrack and ribbon weed forests, winkle and whelk infested crannies, shell scattered and shingly rifts, no part was half so fascinating as the rock-pools. Not the stagnant sort that lie clear of all but the highest tides, occasionally being replenished by wind-driven spray or rain, but those veritable sea gardens, which twice every twenty-four hours have their limpid waters renewed from the great Mother of all life, the ocean ; where weeds—can we call

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them weeds ; should we not rather say sea-blossoms ? —ranging through a multitude of shades from coral-pink to purple, or emerald green to olive and the richest of browns, cling to the slippery sides, or cluster upon the loose stones at the bottom ; where anemones, living flowers of the sea, display their vivid colours as they spread their multi-rayed tentacles—sinister and hungry monsters really, mostly stomachs, but exquisitely beautiful nevertheless ; where the clam and oyster devouring sea-stars curl up the delicate mauve-blue tips of their arms, as they crawl with slow but perceptible movement across the pool bed ; where the hermit crabs, living in some purloined shell like Diogenes in his tub, scuttle from place to place in search of the animal debris upon which they live ; and where fish —blennies, cottids, and gobies—dart in and out the waving fronds and streamers of the marine plants.

Each pool is a perfect little world, one might almost say a self-contained world, where it is possible to imagine a delicately balanced state of life, action and reaction between plant and animal, and animal and animal perfectly poised, so that each species and form might go on living, thriving and reproducing its kind, independent of any exterior influences. But that would be too much to expect, taking into consideration the fecundity and prolific nature of the inhabitants of such a world, and the growth-producing effects of prolonged daylight upon the plant life.

Nature has a better way, and the balance is maintained by the rush and outpour of the sea, when the spawn of the animals and the spores of the algal growths are disseminated through the wider medium of the ocean, and so do not remain to over-crowd

our little pool-world ; when the overgrown weeds are torn from their moorings and carried away, leaving only the smaller, more delicately beautiful plants to decorate the garden ; when too large crabs and blennies, that would soon make havoc of the smaller animal life, are given an opportunity to escape from the little paradise they have outgrown, and carry on their depredations in a wider sphere, more suited to their developing capacities ; and, finally, when such forms of plants or animals as have been temporarily wiped out in our miniature cosmos are renewed from the plankton of the ocean, and given a new chance.

Each tiny pool as it lies in its basin of grey rock, bathed in sunlight, its shining surface just a ripple with the breeze might be taken for a Garden of Eden undefiled by ought that men consider bad in the world, a haven of refuge for the hunted, where peace reigns supreme, and battle, murder and sudden death have no place. But watch ! Mark the stealthy way that crab creeps sideways along the angle of the rock, half hidden by the over-hanging fringe of coral-weed. See him stop, abrupt, only his short antennæ gently waving. He is hunting ; hunting for some living thing to tear and devour. Watch the blenny on the rounded rock above him. The beautiful markings of his sides and fins, breaking, as they do, the outline of his form, are not the result of mere accident or chance. They have their purpose ; they render him almost invisible as he lies perfectly still on the rock. Why ? Because on the one hand death lurks, waiting for him, and on the other, since he must live, he lies in wait for his prey. When he moves, unless it is with sudden alarm that he flies for safety to the dark cranny he has just quitted, there is something very stealthy about him

too. That starfish, there, what is he after ; what is he doing ? He has a harmless dog-winkle held firmly within the grasp of his bent-to arms, and he is eating, or going to eat, the wretched mollusc. Did I say harmless ? Nay, on the contrary, when the starfish caught him he was in the very act of boring through the shell of a mussel in order to get at the succulent tissues within.

Here, then, is a revelation ! Where all is so beautiful, so exquisitely wonderful, so perfect as to thrill one to the very core of one's being, we discover death—death by violence. Life eating life. It comes as a shock to our minds ; yet why should it ? We ourselves are beautiful, and, what is more, we can appreciate beauty : we enjoy life ; we sing ; we dance ; we play ; but it is all at the expense of some other life ! Without taking life we cannot live. It is Nature's most inexorable law. Do we consider the oyster's right to live when we tear open his shell, lacerating the quivering tissues, torturing them with salt and vinegar, finally swallowing him whole ? Why, then, are we so bitter when our turn comes to provide life for some other struggling organism ? We live more intensely than the oyster ; we have a far greater appreciation of what life is and contains ; we are infinitely more capable of enjoyment. Shall we not pay more ? Surely he is a sorry creature, who, having received so much from Nature, begrudges to pay more abundantly than the lowly organisms that have so little ?

To live, to live, and go on living—that is the cry. Every living thing is imbued, whether consciously or unconsciously, with the ardent desire to life ; it is the very essence of all organic being ; but since all matter is unstable, especially the complex compounds of which we are made, that in which life is wrapt up



(Photo by A. de Sowerby)

A typical rock-pool in Cornwall, the haunt of an abundant marine life



(Photo by A. de Sowerby)

Low-water mark, where, only, are some of the rarer marine animals to be found.

cannot endure indefinitely, nor can any single individual, whether a lone cell or a group of cells, go on living for ever. Let us, then, be thankful that ours is the lot to live longer, more intensely, with more appreciation than most of Nature's children, and when the time for reckoning comes, let us pay gladly, instead of blaming the Creator for His sorry scheme of things.

But to return to our rock pools and the life they contain. When we had ascertained that the best and most promising of them lay to the west of the pier, that is, below the spur where a bathing place "for men only" has been prepared, we soon got to work with our investigations, and, during our stay in the district, whenever the tides were right, we spent many pleasant and instructive hours in pursuit of the marine marvels, to which, in the aggregate, has been given the name of the Tidal Benthos.

Benthos, it may be explained, is the name given by scientists to the whole mass of marine animal and vegetable life that occurs on the sea bottom, either being anchored, as the weeds, barnacles and corals, or creeping as the crabs, molluscs, and most of the worms. The Tidal Benthos is that part of the whole which exists between tide marks on the coast. Oceanographers have found that in order to deal systematically with the life of the ocean, it is convenient to divide it up into groups, and so besides the benthos just explained, there is the Nekton, which includes all powerful swimming animals that can range over wide areas. To this belong the whales, seals, nearly all fishes, and some molluscs such as cuttles and squids. The third great group is the Plankton, which is made up of all the floating and drifting organisms of the sea.

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These are to a large extent microscopic, and to the group belong the unicellular algae known as Diatoms, and the protozoan animals called Radiolaria and Foraminifera. To it also belong a great many spores of the anchored weeds, as well as the spawn and larvæ of numerous crustaceans, molluscs, and fishes. Even some of the adult crustaceans and molluscs belong to the plankton.

It must not be supposed that we recognised off hand everything in the way of animal life that we found in the rock-pools round Penzance and elsewhere on the Cornish coast, but with the help of various useful books of reference, with which every investigation should be supplied, and which had been brought for the very purpose, and an occasional trip to the local museum, we were able to identify most, if not all, of the treasures we found.

And what a naturalist's paradise each tiny pool proved to be! A detailed description of each of the many organisms, animal and vegetable, that exists within the narrow compass of those slippery rock-walls, would fill a large volume; while a single chapter is all too short to give the reader a fair idea of the subject; yet that is the most we can hope to do, and, if what is written here stimulates some holiday maker to go in search of more, himself becoming the investigator, then our purpose is well served.

The higher world of vertebrates is represented in the rock-pools by various forms of fishes. Next in the scale come the Tunicates, those peculiar animals that begin life in a free-swimming state, true, but primitive, chordates with a spinal column and other organs of a rather advanced nature, and end up in being more like sea-cucumbers, anemones, or even sponges in appearance, some anchored to

firm objects, others free, and losing nearly all outward semblance to the higher forms of life to which they rightly belong. Below the tunicates, one group of which are known as Ascidiants, in the rock-pool animal life, are the Polyzoa, organisms that live in colonies something like those of the corals, and which may be found in layers upon rocks, seaweeds, and the shells of molluscs. This group is followed in descending scale successfully by the Echinoderms, that is, the brittle-stars, starfishes, sea-urchins and sea-cucumbers, or holothurians; next the well known Molluscs, represented by such forms as the winkles, the limpets and a few bivalves; the Crustaceans—crabs, shrimps, sand-hoppers and isopods; the Annelids or worms; the Rotifera, minute, almost microscopic, but still very complex, organisms; the Porifera, or sponges; the Cœlenterates, including the sea-anemones, jelly fish and corals; and, finally, the truly microscopic Protozoa, unicellular organisms, of which the amœba, though not an inhabitant of rock-pools, is, perhaps, the best known example.

As regards the vegetable kingdom, we may say that the plant life of our rock-pools is confined to one class, the Algæ, containing the more advanced, multicellular, attached seaweeds, and the very primitive microscopic diatoms and other unicellular forms. The sea-weeds, it may be remarked, though in many cases having the outward semblance of the higher land plants, with stems, leaves and roots, are when examined microscopically, found to be nothing more, structurally, than masses of very simple cells or interwoven filaments, and possessing only very primitive reproductive organs.

In the course of our investigations we found representatives of most of these groups of living

organisms, but it is my purpose here to mention briefly only the more conspicuous forms.

The first glance one gets into a pool, as one comes to it over the rocks, does not reveal much more than the masses of coloured sea-weed, but if one remains on the brink, keeping perfectly still, and gazing steadily into the clear water, one soon becomes aware of many things. It is probably that the first thing to attract one's attention will be the fishes, and of those the commonest will be the so-called Shanny, a species of blenny rejoicing in the scientific name of *Blennius pholis*, Linn. This form in varying stages of growth may be seen moving about close to the bottom, or over rock surfaces, always ready to dart into some dark crevice if danger threatens. Other very common little fishes are the Goby (*Gobius paganellus*, Gm.) and its smaller relative the Two-spotted Goby (*G. ruthensparri*, Euphr.) but as a rule to find those one must turn over stones and weeds, when, also the Five-bearded Rockling (*Motella mustela*, Linn.), the Cornish Sucker (*Lepidogaster gouanii*, Lacép.), which clings to the under surface of the rocks with the tenacity of the limpet, the little Cottus, or Father-Lasher (*Cottus bubalis*, Euphr.), and the Worm Pipe-fish (*Nerophis lumbriciformis*, Yarrell) may be found. All these forms are common along the Cornish coast, and may be considered as typical inhabitants of the rock-pools. Later I am describing these fishes in more detail, as well as many other animals and plants mentioned here, so need do little more for the present than give their names.

A number of crabs will also be found in almost any pool in the district. Some, such as the Common Shore Crab (*Carcinus mænas*, Linn.), and the Swimming Crab (*Portunus depurator*, Linn.) may be seen

moving about the bottom, on the prowl for food. A small mass of mixed sea-weed moving from place to place turns out to be a beautifully camouflaged Spider Crab (*Maia squinado*, Herbst.). This crab deliberately masks itself by sticking pieces of wood on its back and legs, where they are held in place by long hairs. In the crannies, and half hidden under the larger stones, small specimens of the Edible Crab (*Cancer pagurus*, Linn.), and the rock loving Furrowing Crab (*Xantho incisus*, Leach) may be found. If the stones are turned over a great hurrying and scurrying betrays the presence of two small crab-like forms, the so-called Porcelain Crab (*Porcellana longicornis*, Linn.) and the closely allied hairy species, the Broad-clawed Crab (*P. platycheles*, Pennant). If the pool happens to be fairly near low water mark, another interesting crustacean, belonging to the same group, but of very different appearance, may be found under the stones. This is the Plated Lobster (*Galathea strigosa*, Linn.) and when thus rudely disturbed, it flips about by means of its bent under "tail," causing a great commotion. It is very like a crayfish or lobster, and one would not readily associate it with the group containing the porcelain crabs. Other crustaceans to be found in the same spots are the well known sand-hoppers, such as *Talitrus saltator*, Montague, and the peculiar little isopod known as *Idotea balthica*, Pallas. Frequently small, or even half grown specimens of the Common Prawn (*Leander serratus*, Penn.) may also be captured in the rock-pools, but these do not hide under stones, keeping rather to the protection of the weeds. Hermit crabs, of which the commonest species is *Eupagurus bernhardius*, Linn., are also extremely abundant, and may be seen scuttling

about over the stones and weeds in a very active and business-like way.

Of molluscs the commonest species to be found in the pools are the four kinds of top shell, namely, the Thick Top (*Trochus lineatus*, Da Costa), the Flat Top (*T. umbilicatus*, Mont.) the Grey Top (*T. cinerarius*, Linn.), and the Common Top (*T. zizyphinus*, Linn.). Other common forms are the Common Winkle (*Littorina littorea*, Linn.) the Dwarf Winkle (*L. obtusta*, Linn.) the Nettle Dog-whelk (*Nassa reticulata* Linn.), and the Dwarf Dog-whelk (*N. pygmæa*, Lamk.). On the adjacent rocks will be found numerous specimens of the Common Limpet (*Patella vulgata*, Linn.), the Purple, or Dog-Winkle (*Purpurea lapillus*, Linn.) and the Sting-winkle (*Ocinebra erinacea*, Linn.), all three of which wander into the pools at times. Though empty shells of the little European cowry (*Cypræa europea*, Mont.) are numerous at the bottoms of the rock-pools, the live animals do not occur there, but further down below low tide mark. If a careful examination of the ribbon seaweeds (*Laminaria*) be made the beautiful young of the Blue-rayed Limpet (*Helcion pellucidum*, Linn.) will be noticed. These have small semi-transparent shells with several rows of bright, opalescent blue dots, radiating from front to back. As they grow the blue dots become less plain, finally giving place to narrow rays of a light colour. In this limpet the margin of the shell becomes thickened and is always smooth. Amongst the most interesting molluscs that are to be found in the pools are the Mail-shells, or Chitons. At least one species, the Grey Mail-shell (*Chiton cinereus*, Linn.) is fairly common in such situations on the Cornish coast, where it may be found clinging to the under sides of loose stones not far from low tide mark. Something like a limpet, the mail-shell may be easily

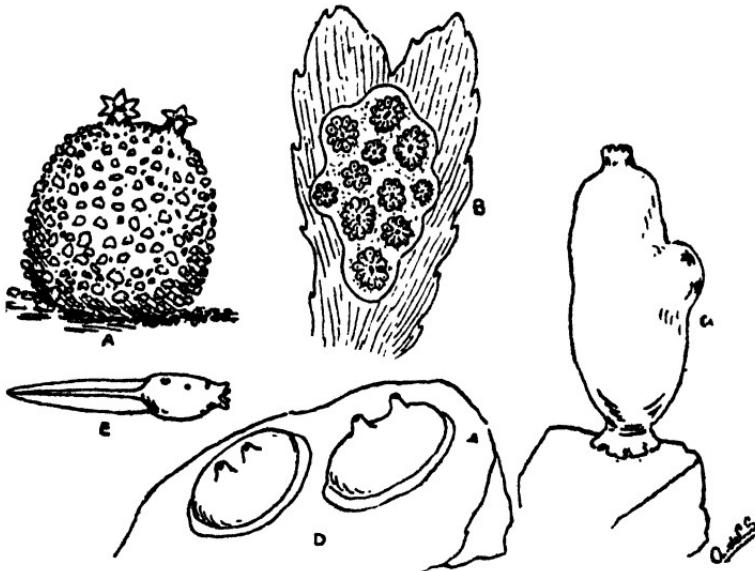
recognised by the eight dorsal plates of which the shell is composed. The order *Amphineura* to which the chitons belong is represented in Cornish waters by some eleven species at least. An interesting feature of the order is that some of the forms have a large number of eyes on the dorsal surface. This may be in compensation for the absence of eyes, and tentacles on the head of the animal, which otherwise resembles that of the limpet. When pulled off the surface to which it is clinging the Chiton curls up much as does the little Millipede (*Glomeris marginata*), or the little land isopod, popularly known as the Pill Bug, and whose classic name is *Armadillidium vulgare*. With the exception of two species, the bivalves do not seem to favour rock-pools. In the crannies between the rocks, well anchored by means of strong, almost fibrous filaments, known as the byssus, numerous Common Mussels (*Mytilus edulis*, Linn.) may be found, ranging from small, shiny black shells to large, purplish ones, the purple colour most conspicuous where the shell has become worn round the beak. Sometimes a brownish horn-coloured specimen with dark rays occurs amongst the others. Less numerous, but still fairly common, is the Pullet Carpet-Shell (*Tapes pallustra*, Mont.). This species, however, is not really an inhabitant of rocky parts, but of sandy beaches from between tide-marks down to twenty fathoms, and apparently gets into the rock-pools only by accident. Of course, the empty valves of other Pelecypods as the bivalves are called, may frequently be found, notably those of the Pod Razor-shell (*Solen siliqua*, Linn.), the Quinn, or Queen scallop (*Pecten opercularis*, Linn.) and the Common Piddock (*Pholas dactylus*, Linn.) often in a more or less broken condition. The last is a rock boring species, and its shells are seldom found outside their

burrows in a perfect state. The almost papery valves of the little Saddle Oyster (*Anomia ephippium*, Linn.) are fairly abundant on stones, shells, the backs of crabs, and other places.

A mollusc that occurs commonly in the rock-pools and that should be searched for on the stems and "roots" of the ribbon weed is the Red Doris, a species of sea-slug known to science as *Doris coccinea*, A. & H. This animal, which measures about an inch in length, is of a reddish colour, and has two plumules anteriorly and a soot on its posterior dorsal surface. It is also covered with little granulations. It feeds upon the Red Sponge (*Halichondria sanguinea*) which it closely mimics in its colour and appearance, thus escaping detection by its enemies the fishes. Most of the sea-slugs are thus peculiarly adapted to resemble the organisms on which they live and prey, notably *Goniodoris castanea*, A. & H., which resembles the various forms of tunicate on which it feeds.

Tunicates, it may be remarked, are peculiar, more or less shapeless animals, that are classed with the vertebrates, since in their early stages they show the presence of a notochord, or primitive spinal column. At that stage they are free-swimming tadpole-like larvæ, but later in life they mostly become attached to some surface—rock, stone, shell, or wood—and by a process of what might almost be called degeneration, lose all resemblance, outwardly, at least, to the vertebrates, and become, some mere shapeless masses of living matter, others colonies of very beautiful flower-like growths upon the surfaces to which they have become attached. Of the latter a form called *Botryllus smaragdus* is very common in the rock-pools of Penzance. It may be found on the blades of the seaweeds or on stones, and has the

appearance of a thick film of gelatinous substance in which are buried numerous green blossoms. As a matter of fact each "blossom" represents a group of Compound Ascidians, as they are called, each "petal" being a single animal. Other members of the genus *Botryllus* recorded from Cornish waters are *B. violaceus*, M.-Edw., which is blue with white lines, *B. schlosseri*, Pall., *B. gemmeus*, Sav., *B. rubens*, A. & H., *B. virescens*, A. & H., and *B. bivittatus*, M.-Edw. These are all very beautiful forms, but the individual animals are almost too small to examine comfortably. Larger forms occur, some as colonies, some as single individuals, and these may be examined by the



TUNICATES.

- A.—*Molgula oculata*, Forbes, a single and free form in which the test, or skin, gets covered with particles of sand.
- B.—*Botryllus smaragdus*, M.-Edw., in which a number of groups of individuals are embedded in a mass of gelatinous substance, on the blade of a seaweed.
- C.—*Ascidia mentula*, Müll., a single attached form.
- D.—*Styelopsis grossularia*, van Ben., a single attached form.
- E.—The Tadpole-like Larva of an Ascidian greatly enlarged.

student. In the larval stage, which again is too small for an easy examination, the animal, as already indicated, somewhat resembles a miniature tadpole, and has a notochord, as well as what may be called a spinal nerve, and a brain, the first running down the tail. There also gill-slits in the pharynx, a heart, a mouth on the dorsal surface, a single eye on the right side, and what are called fixing organs at the anterior end of the body. In maturity most of the Tunicates lose these characters degenerating into mere scales with two orifices and covered with an outside test or skin. Through the orifices, one of which is the mouth and the other the atrial orifice, a stream of water is kept circulating through the animal. The tail becomes absorbed, the brain a minute organ hidden in the tissues, the notochord disappears, as does the spinal nerve. In the compound Salpiform Ascidian known popularly as the Fire-flame (*Pyrosoma elegans*) which occurs in the Mediterranean, a large size is attained, often as much as three feet in length, the whole colony being in the form of a hollow tube, closed at one end, with the atrial orifices of the animals opening into the hollow, the mouths exposed to the exterior, the outer surface also being covered with numerous tentacle-like outgrowths. This beautiful creature owes its name to its highly phosphorescent character. The members of the genus *Salpa*, of which *S. fusiformis*, Cuv., and *S. mucronata*, Forsk., have been recorded from Cornish waters, and which belong to the order Thaliacea, may occur as free individuals or in beautiful swimming chains. In *S. fusiformis*, an individual of a chain is fusiform, or pointed at both ends, a solitary individual is truncated at both ends; while members of the genus *Doliolum*, belonging to the same order, *D. nationalis*, Borg.,

having been recorded from the Plymouth district, are shaped like barrels. Besides these forms there are some less beautiful ones, such as the single and unattached *Molgula oculata*, Forbes, and the single and attached *Styelopsis grossularia*, van Ben., both of which belong to the group called Simple Ascidians, the latter being a red coloured form found commonly clinging to stones or shells in rock-pools.

Of the sponges (*Porifera*) the commonest is the Crumb-of-bread Sponge (*Halichondria panicea*, Pall.), which may be found on rocks or on the stems and "roots" of seaweeds. In it the surface of the irregular mass is in the form of small, closely set cones, each with a hole at the top like the crater of a volcano, through which a current of water is continually expelled from the interior channels of the sponge. Water is drawn into the latter through numerous minute pores on the surface. In colour this sponge is yellowish or greenish. Other members of the genus also occur.

Fairly common in our rock-pools are four members of the great phylum *Echinodermata*, the Sea-urchins, Sea-stars, and their kin. These are a small, flat, short-armed Sea-star called *Asterina gibbosa*, Pennant the large Sea-star (*Asterias glacialis*, Linn.), a Brittle Star called *Ophiothrix fragilis*, Müll., and small specimens of the Edible Sea-urchin (*Echinus esculentus*, Linn.). Several members of the *Holothuroidea* or Sea-cucumber class may also be found in the rock-pools. Of all these forms the large Sea-star is a beautiful animal, perhaps less common than the others. It preys mainly upon bivalve molluscs, which it envelopes with its arms, forces open by pulling the valves apart, and then proceeds to digest by egesting its own stomach and enfolding its victim, ultimately leaving the empty shell behind. To pull

the valves of the mollusc apart considerable strength must be exerted by the star-fish, for it is well-known how powerful are the adductor muscles of such a shell-fish as, say, a mussel. In a large specimen caught in one of the rock-pools at Penzance the colour was creamy buff, pinkish underneath, and changing to mauve and then pale-blue at the tips of the arms. The Common Sea-star (*Asterias rubens*, Linn.) occurs less in the rock-pools left by the tide, but more abundantly below low water mark, being washed ashore in rough weather.

Representing almost the lowest form of animal life are the Sea-anemones, which belong to the class *Zoantharia* of the Coelenterates. Several very beautiful forms occur in the Cornish rock-pools. They are too familiar to need any detailed description. With them may be classed the Corals.

Besides these various forms of life there are, of course, numerous members of the very simplest unicellular animals, but these being so minute will not be noticed by the open air student, and require for their proper examination a laboratory and microscope.

Turning from the fauna to the flora, it will be noticed that the beautiful array of foliage, and the display of colour are due mainly to the few species of algae. The reds and crimsons are supplied mainly by such dainty forms as *Callophyllis laciniata*, *Lomentaria articulata*, and *Ceranium rubrum*. Of these the first has a flat, frilled frond, the second is at once distinguishable on account of its segmented or jointed appearance, and the third by its long filaments being handed in a characteristic manner. These three grow on the rocks. On loose stones and boulders in the pools thick masses of vivid green weeds grow. There are several forms, of which the

two commonest are *Enteromorpha compressus*, with narrow, tubular, branched fronds, and *E. intestinalis*, having somewhat wider, but still not broad, unbranched fronds. A third green form is the sea Lettuce (*Ulva latissima*), whose frond is in the form of a broad, irregular, more or less crinkled membrane. *Porphyra laciata* is very similar in shape to the Sea Lettuce, but is of a brown, dark-red, or purplish colour. Everywhere the dainty Coral-weed (*Coralina officinalis*) forms a thick growth on the rocks, showing a deep mauve colour when low down in the water and gradually getting lighter till it is pink or even whitish near the surface. On all the rocks overhanging the sides of the pools are the common Bladderwrack (*Fucus vesiculosus*), and the equally common Serrated Wrack (*F. serratus*), while on the tops of the rocks clear of the water at low tide grow thick, short tufts of *Pelvetia canaliculata*. Long, branched strands of *Himanthalia lorea* sprouting from the mushroom shaped bases characteristic of the plant, and the filaments of *Chorda filum*, like brown leather boot-laces, straggle over the rocks and into the pools that lie near low water mark. Still further down the pools become more and more filled with the various forms of Ribbon-weed, or *Laminaria*, till these make a veritable jungle, and in place of the lovely orderly little gardens, we have a wild tangle of thick snake-like stems and long curly ribbons, a regular wilderness of growth. There also may be found bunches of the heath-like *Cystoseira ericoides*, a brown weed that often takes on a beautiful, elusive iridescent blue colour, as it waves gently under the rippling surface of the water.

CHAPTER II

THE EELS' WONDERFUL JOURNEY

ONE day while our little party, Sonny, his Mother and myself, was hunting amongst the rocks just below the Railway Station at Penzance for shells, our particular quest being Rockborers or Piddocks, only fragments of which had as yet been secured, in turning over a large rock a tremendous commotion was observed. Twenty blennies or gobies could not have caused such a flurry. Some large fish was dashing about in the shallow pool, churning up the water and shaking the green weed, in its mad endeavours to find a safe retreat. It was soon seen to be an eel, and the chase it gave us before it was finally caught and safely deposited in Sonny's shoe—an ever ready receptacle—was worthy of far larger and nobler game.

Over the smooth rocks it went, under stones, through the pools, and into the masses of brown wrack, whence it was once more driven out by overturning the heavy clusters of leathery foliage. When captured, the prize, carefully guarded all the way, was carried home, and placed in a basin, where it could be properly studied.

The first thing noticed was that, whereas all the other fishes that we had brought home from time to time had soon died when placed in fresh water, the eel seemed perfectly contented; nor did the meagre supply of water, whose dissolved oxygen

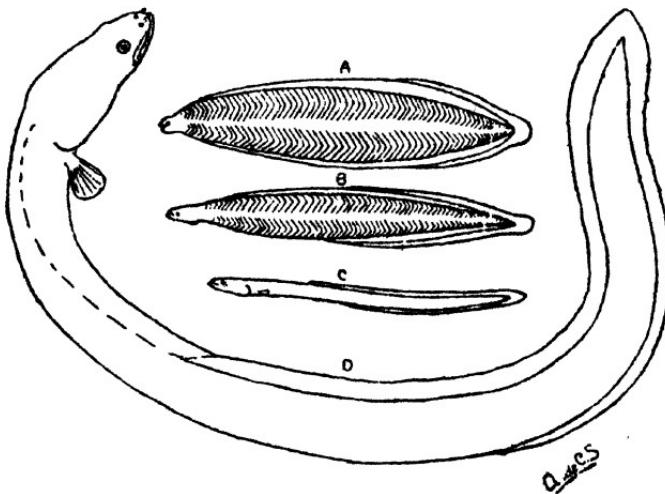
must soon have been consumed, seem to inconvenience it at all. In fact, it lived on for several days, and only succumbed when warm water was added to its basin in order to kill it before adding it to the formaline bottle.

On another occasion two small eels were discovered under a stone, where fresh water flowed from a small spring down to the sea. One of these also was captured after an exciting chase. Of course, the discovery of these eels in fresh water and the other one in salt water needed explaining ; and so, one thing leading to another, the whole subject of the wonderful life history of the common eel and its journey into the uttermost parts of the ocean was opened up. The story in all its fascinating detail has been told before, but it will bear repetition ; indeed it is doubtful if, even with all the telling, it is familiar to more than a few of that wide class of people, the casual readers.

Few people who are acquainted with the Common Eel (*Anguilla anguilla*, Linn.) of our ponds and rivers, either in its native haunts or merely as a table delicacy, are aware of the fact that this, one of the commonest of the fishes of both British and Continental waters, long supplied naturalists with one of the greatest mysteries of the fish world.

The elucidation of this mystery, the final consummation of which has, apparently, recently been brought about by the Danish ichthyologist, Schmidt, is one of the triumphs of modern marine biological research ; and, at a time when the wide, though comparatively new, science of Oceanography is raising such general interest and calling for renewed support in its far-reaching scope, it may well be cited as a good instance of the usefulness of that science to mankind.

It was long known that eels living in our rivers repaired to the sea for breeding purposes. It was even known that those living in isolated ponds actually made overland journeys in order to reach the streams and rivers; though in this connection it is interesting to note that such a writer as Yarrell (1861) believed that under certain circumstances eels spawned in inland waters, a belief now well established to be contrary to fact.



Successive stages in the development of the Common Eel. A and B, Leptocephalus stage. C, Elver. D, Yellow Eel.

The chief mysteries in those days were the whereabouts of the spawning grounds, and since no one had ever found eels in the act of spawning, whether they were oviparous or viviparous, that is to say, whether the elvers were born in a free state or hatched out from eggs, as most other fish are.

At the same time that such authorities as Yarrell were forming conjectures about the breeding and spawning habits of the common eel, they were also discussing the peculiarities of a small fish which

they classed with the eels in the family *Muraenidae* (*Anguillidae*), and that had recently been found in the sea. To this had been given the generic name *Leptocephalus*, and certainly from its laterally compressed, rather deep, transparent body, there was little enough about its appearance to connect it with the common eel. Indeed, it was actually larger than the elvers, or young eels that annually appeared in swarms in the estuaries of our rivers.

However, other naturalists, working contemporaneously, had arrived at the truth, suggesting, as they did, that the fishes known as *Leptocephali* were in reality larval stages of the common eel and the conger ; which fact was finally demonstrated in 1886 by Delage by actually rearing a young conger eel from a specimen of the form called *Leptocephalus morrisii*, which had been named after its discoverer, William Morris, by Pennant.

The connecting of *Leptocephalus* with the true eels only deepened for a time the mystery surrounding the spawning place and habits of the latter. Nevertheless there have been those who have persistently probed that mystery, foremost and most successful amongst whom has been Dr. Johann Schmidt, of the Carlsberg Laboratory, Copenhagen, and to-day the whole life history of the common eel may be written with a considerable degree of confidence.

At the recent meeting of the British Association at Cardiff, Professor W. A. Herdman, in his presidential address called attention to the fact that Dr. Schmidt, who since 1904 had been carrying out investigations in search of the spawning grounds of the common eel, had, in moving westward across the Atlantic from Europe, "found successively younger and younger stages" of the leptocephalous

larvæ, and was during the past summer (1920) "engaged in a traverse of the Atlantic to the West Indies in the hope of finding the missing link in the chain, the actual spawning fresh-water eel in the intermediate waters somewhere above the abysses of the open ocean." This address was delivered on August 24th, and within two days, that is on August 26th, it was announced from Copenhagen in the daily papers that the actual spawning grounds of the eel had been discovered off the West Indies by Dr. Schmidt. Thus, at last, if the report be true, has been solved a mystery that has been puzzling mankind for over two thousand years, for, as Yarrell says, "Aristotle believed that they (eels) sprang from the mud; Pliny, from fragments which were separated from their bodies by rubbing against rocks."

In studying the life history of the common eel, let us choose for the purpose a specimen of the fish in the stage most familiar to everyone, and follow it through the life cycle. The so-called Yellow Eel may be found in various places, such as rivers, streams, ponds and marshes, and for our purpose we may select a female of about eighteen inches in length, inhabiting, say, a pond in an open field. Here the eel lives, keeping mostly to the bottom and feeding upon all sorts of things—worms washed into the water by the rain, various aquatic insect and crustacean life, the spawn of other fishes, frogs, garbage, and even the leaves of aquatic plants. As it grows and approaches maturity a wonderful change comes over it. Having ceased to feed it gradually changes in appearance, losing the yellowish colour and becoming whitish below and dark greyish above. Its eyes grow larger. It is now known as a Silver Eel. At one time Silver Eels were supposed to be specifically distinct from yellow eels. What

is most wonderful about this change is that it fits the eel for a deep sea life. Already its elongate form is to a considerable extent characteristic of many deep sea fish, and to this is now added the large eye, also typical of many sea fish, while the darkening colour is also in preparation for what is to come. Leaving the pond, generally choosing a dark rainy night, it heads across the fields for the nearest stream, having reached which it commences to work its way down to the river and so to the sea.

While still in the river it meets many more of its kind, males and females, and some strong social instinct, prompted no doubt by approaching maturity, causes a number of eels to come together, intertwine their sinuous bodies, till they form a large ball of living, writhing, serpentine forms rolling or floating down stream.

It has been observed that eels from different parts of Europe commence their journeys at different times of the year, the migration beginning as early as May in Sweden, and taking place as late as October or November in the Severn. But apparently this is to ensure the arrival of the eels at the spawning grounds at about the same time, since the further they are from the Atlantic the earlier seems to be their start.

Our eel now grows still darker and its eyes still larger, thus becoming more fitted for its deep sea existence.

Leaving the comparatively shallow waters of the river-mouth it travels westward, or south by west, as the case may be, into deeper and deeper water. At last it reaches the edge of the continental shelf where the great deeps of the Atlantic Ocean begin. Down it goes over the edge, and now its form serves it in good stead. The darker colour renders it less

visible than other hues would in a region where, more and more, the various rays of light are being absorbed. The enlarged eye on the other hand helps it to see more clearly, though it must be admitted that at the depths it has now reached, it is doubtful if even so it can see much. Down, down, it goes into regions where, in the words of Tennyson :

Below the thunders of the upper deep ;
Far, far beneath in the abysmal sea,

* * * * *

. swell
Huge sponges of millenial growth and height
And far away into the sickly light,
From many a wondrous grot and secret cell
Unnumber'd and enormous polypi
Winnow with giant arms the slumbering green.

At a considerable speed it crosses the floor of the Atlantic, encountering on its way strange creatures of the deep sea benthos. It feeds not as it swims, being consumed by the one all important desire to procreate, and finally it reaches the abysmal regions off the West Indies right on the other side of the ocean. Here, in the company of millions of its kind it goes through the process of spawning, after which, presumably it dies, having attained the ripe old age of about eight or nine years, and fulfilled the object of its being. Exactly what the process of spawning is we must await the reports of the Danish Expedition to know, but whatever they are, they will be of extreme interest to all who have come under the fascinating influence of the eel's story.

But we have not finished yet. Presumably the eggs hatch out and the larvæ rise in the medium of the ocean till, coming within the influence of the currents they are carried slowly back across the

Atlantic towards the European coasts. They develop as they are drifted eastward into the well known *Leptocephali*, already mentioned, in which stage the young eel is very compressed, or laterally flattened, being the shape of a lanceolate leaf. At one end is a small roundish head, with the two eyes black, the only pigmentation in the whole animal, and a mouth fringed with teeth. At this stage it feeds, but later, when nearing the coast, ceases to do so. It is absolutely transparent and its maximum length is about eighty millimetres. When it reaches what is known as the five hundred fathom line, the larval eel undergoes a metamorphosis. It grows less and less deep in the body ; loses its teeth ; its dorsal and anal fins, which till now were far back, spread forward ; and gradually from a very compressed, lanceolate, planktonic form of fish it changes into a slender thread-like fish suited to a fresh water existence.

These two metamorphoses in the life history of the eel are probably the most extraordinary and interesting in the whole kingdom of fishes, and the elucidation of the mystery of their origin, that is to say, how they are brought about, would have a considerable bearing upon much that is as yet inexplicable in organic life and its changes. In each case the change begins, even if it is not completed, *before* the environment, to fit which it takes place, is reached.

The young eel, now known as a Glass Eel, and still transparent and colourless, continues its journey to the mouth of some river. Here it waits about, apparently till it has become pigmented, and then as an Elver it swims up stream, steadily and persistently making for the upper waters and inland ponds and lakes, having reached which and grown

somewhat in size, it may be considered to have become a Yellow Eel. It lives and grows as a yellow eel for a period of from five to eight years, when maturity approaching, it begins the metamorphosis already noted in connection with its parent.

The male eel, apparently, reached maturity a little earlier than the female, and does not attain so large a size as the latter, which when fully mature, may measure as much as two-and-a-half feet.

Some eels do not ascend rivers, but appear to remain along the coasts. They may thus be found in varying sizes hiding under stones and rocks when the tide has gone out.

When, as sometimes happens, an eel is kept in a place from whence it cannot escape, such, for instance as a suitable aquarium, it neither matures nor undergoes the remarkable metamorphosis preparatory to a deep sea life ; a fact which may help in the discovery of how the change is brought about.

The life cycle of the Conger Eel (*Conger vulgaris*, Cuv.) is essentially the same as that of the common eel ; though, of course, in its case there is no ascent of rivers, the growth period of its existence taking place in the sea along the coasts, nor does the adult conger travel such a distance across the floor of the ocean as does the common eel.

CHAPTER III

LIFE OF THE SANDY BEACHES

“ . . . As we strolled along,
It was our occupation to observe
Such objects as the waves had tossed ashore,
Tangle, or weed of various hues and forms,
Each on the other heaped, along the line
Of the dry wrack”

THE animal and plant life of the rocks and rock-pools have up to the present mainly occupied our attention, but every visitor to the sea coast in search of rest and relaxation from the arduous duties of a mundane existence in town spends a good deal of his, or her, time on the open beaches. Perhaps it will be in strolling bare-footed along the edges of the lapping waves that spread in tiny ripples over the flats at ebb tide ; or it may be in helping the children build their sand castles ; or, not unlikely, in merely reclining at full length upon the sand or shingle, letting the sun's rays beat upon the clothes-free body after a dip, idly throwing pebbles, watching the lazy white gulls float by on pinions fleet, or the fishing boats away out to sea dancing upon the sun-kissed waters. Whatever it be that he is doing, unless he be unusually dull, the fact will hardly escape him that all around him, on the sands, under the sands, in the wrack of the sea left behind by the tide, in the shallows that lap at his feet, there is abundant, throbbing eager life. I have said, unless he be dull he will notice this life :

but, that were going too far, for, after all, the life of the open beaches is not what you might call obtrusive. Unlike that of the rock-pools it may easily be missed by the casual observer. It does not force itself on the notice of the untutored holiday maker. As so often happens in nature, it requires the enlightened mind and seeing eye to discover it. It is there, but much of it needs probing for. And yet, as the tide recedes, many marine animals will be left stranded upon the beach, and these even the most casual cannot fail to notice.

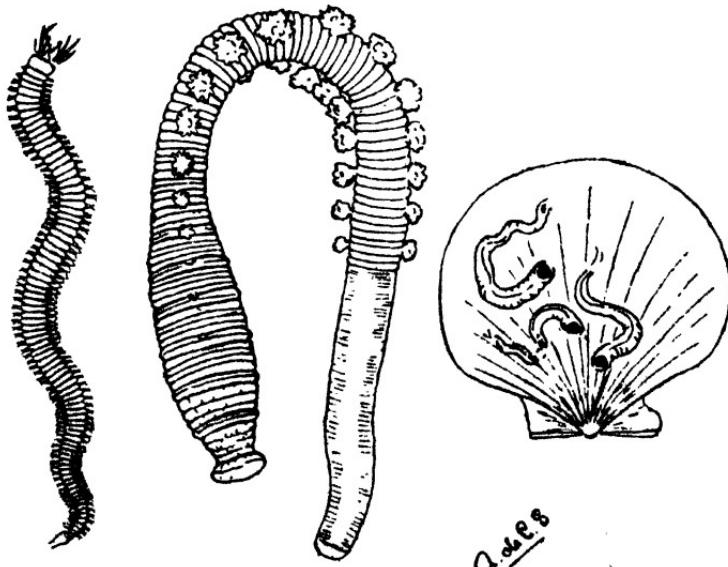
Starfishes, for instance, are common objects of the sandy beaches as the tide goes out. Occasionally a Sea-urchin may be picked up, or a lovely Seamouse (*Aphrodite aculeata*, Linn.), whose iridescent hairy, or bristly, sides will at once arouse the admiration of the finder. There will be sea-shells of various kinds, sometimes just the dead and empty valves, sometimes the living animals ; half dead, or more or less dismembered crustaceans sometimes litter the fore-shore ; at times, even, various species of fish.

If these forms of life, or, rather, if such remains of once living animals be plentiful, it will be because the weather has been stormy, and the winter visitor to the coasts will find them much more common than will he who resorts to the seaside only in summer.

But what of the *life* of the beaches ? There are many kinds of animals that make the beaches their home, and it will be found that many of these are worms of some sort or other. In fact, the mudflats and sun-flats that occur below the sharper slope of shingle and sand, the strips that are not always uncovered by the retreating sea, even at low tide, might almost be called the worm zone. The true Lug-worm (*Arenicula marina*, Linn.), the large, fat

blackish or brownish-green worm with bright red gill-tufts down its body, so beloved of the fishermen as bait for sea fish, is very plentiful in these low flats, especially if they are muddy. Everywhere the little hillocks of digested sand, littering the surface, betray its presence. This species belongs to the group or order called *Polychæta*, and there are some hundred and fifty odd other species of worms belonging to the same order that have been recorded from Cornwall. By no means all of these are to be found in the sands at low tide, many having been dredged in deeper water, many others belonging to the rocky parts of the coast ; but a good number of them are to be found in the zone under discussion.

For instance, there are members of the genus *Nereis*, also called lug-worms by the fishermen, of which one form, the Mud-lug (*N. cultrifera*, Grube), lives in the mud between the stones at the bottom



Rock-lug (*Nereis pelagica*, Linn.), Sand-lug (*Arenicola marina*, Linn.), and the shell of the Serpula Worm (*Serpula vermicularis*, Linn.) on the shell of a Scallop.

of the harbour in Penzance, and another, the Rock-lug (*N. pelagica*, Linn.), in the sand and muck amongst the rocks. The Sand-lug (*N. dumerilli*, Aud. & Edw.) lives in the sand at low water mark, as also does *N. irrorata*, Maligreen. One form, *N. fucata*, Sav., lives in dead shells of the common whelk, especially those occupied by the common hermit-crab. Keeping to the topmost whorls, it is safe from the crab, at the same time feeding, doubtless, from its host's table. These worms are long, slender, and have the sides of each segment of the body drawn out into what are called parapodia (like legs), from which grow the hairs or spines called chætæ. In *N. pelagica* the parapodia are comparatively small, in *N. cultrifera* much larger, giving the worm, which is very active, a fringed or frilled appearance. In both these species there is a distinct head with spiny jaws and tentacles. To these are related the swimming Paddle-worms (*Phyllodoce*), in which the parapodia are even larger with leaf-like paddles, which enable the worms to swim with ease. Then there are the little worms known as the Sand Masons (*Pectinaria*), which make for themselves delicate tubes of grains of sand most wonderfully cemented together, and the Shell-binder Worms (*Terebella*), which do much the same with pieces of shell, and whose long tubes may be found partly buried in the sand, under stones, and in the debris of the rock crevices. Another species of worm that builds tubes for itself is the Peacock Sabella Worm (*Sabella pavonina*, Sav.), which may be found at low tide where sand and mud are mixed. It, too, has been recorded from Cornish waters. It has a crown of red and white gill-plumes, which may be seen protruding from the ends of the tubes. The Serpula Worm (*Serpula vermicularis*, Linn.) forms a

tube of shelly substance, which may be found on stones and the shells of molluscs, notably of scallops. Others occur in large colonies on stones, as well as amongst the rocks.

The Sea Mouse, already mentioned, is in reality a Polychæt worm, and there are many others too numerous to mention.

Then there are the Nemertine worms, lowly organisms that do not belong to the true worms, or *Annelida*, some of which are to be found in the mud and sand at low tide. The still more primitive Flat Worms (*Turbellaria*) are also to be found in such places.

Many of the molluscs, whose empty shells at times litter the surface of the sand, may be found alive in the sand itself. One of the commonest of these is the Razor Shell (*Solen siliqua*), which buries itself vertically leaving a small opening to be used when the tide flows over its hiding place. Another is the Thick Trough Shell (*Mactra solida*), and the Common Cockle (*Cardium edule*) another. Frequently the empty valves of these animals will be found with a little round hole bored in each. These holes are the work of such species of Gastropods as the Necklace Shell (*Natica catena*), which plough into the sands in search of their prey, boring a hole through the shell of the bivalve when found by means of their toothed proboscis, and devouring the unfortunate animal inside. These forms may be found by digging for them, but they usually occur rather low down on the fore-shore, close to low water mark.

The Heart Urchin (*Echinocardium cordatum*, Penn.) is also to be found buried in the sand near low water mark.

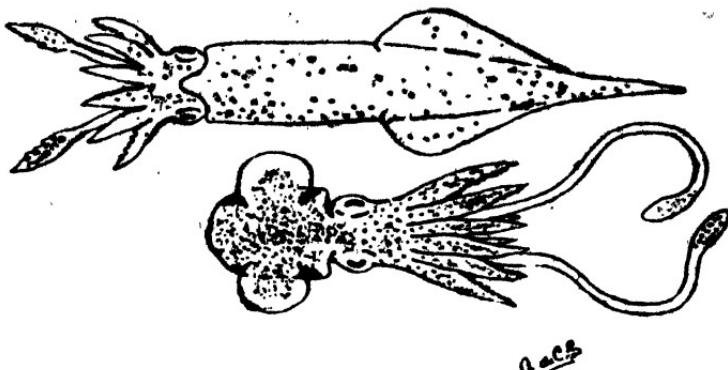
If the sea wrack that is left behind by the tide be turned over, it will be seen to be alive with small

jumping creatures that will give one the creeps to watch. Catch one and examine it, and it will turn out to be nothing more unpleasant than the harmless sand-hopper, two species of which are very common in such localities. These are *Talitrus saltator*, the Common Sand-hopper, and *Orchestia gammarellus*.

Hiding in the gravelly shingle and coarse sand where such are reached by the tide, numerous very small, often microscopic crustaceans known as Copepods may be found. These are very minute and primitive members of the great group to which they belong, and occur also in countless numbers in the plankton of the ocean.

Sometimes the peculiar Masked Crab (*Coryistes cassivelaunus*, Pennant) may be found in the sand near low water mark ; for it, too, lives buried in the sand, usually preferring sandy bottoms in fairly deep water. It gets its popular name from the fact that its carapace is scoured or grooved in such a way as to make it resemble a human face. In this species the male is characterized by its very much longer claws, or chelas, than those of the female.

In the shoal water that sweeps the flats as the tide begins to flow are other crustaceans such as shrimps and prawns ; while if the observer will but take a few turns with a shrimping net, he will find in its folds, when he brings it ashore, numerous small fishes the young of such species as soles, plaice, and dabs. He may also capture beautiful little cuttles, or squids, and sefsias, which frequent shoal waters in these parts. Of this type of animal, called Cephalopoda, meaning "head-footed," the form most likely to be captured is the little *Loligo* (*Loligo media*, Linn.). This lovely creature is elongate, dart-shaped, the head end having ten rather short tentacles, the



O. A.C.B.

The Little Loligo (*Loligo media*, Linn.), and the Little Cuttle (*Sepiola atlantica*, D'Orb.), both fairly common species in shoal-waters on the South coast.

opposite end terminating in a point. There are two fins, or wing-like flaps on the sides of the body. Its chief charm is its colouring which changes repeatedly as one watches, at times being dark greyish or purplish brown, at others pale iridescent. By looking closely it may be observed that there are variously coloured spots on the loligo's skin, which increase and decrease in size, and so bring about the changes of colour. When all the black spots are expanded to the full the animal is very dark ; when the red are expanded it assumes a rosy hue and so on.

The Common Cuttle (*Sepia officinalis*, Linn.) and the Common Squid (*Loligo forbesii*, Steenstr) are both commonly distributed along the south coast of Cornwall ; while the shell of the little *Spirula peronii*, Lamk, are said to be frequently cast ashore. It may be explained that in this species, which is small with a rounded body there is a small coiled shell inside the tissues of the body, which appears to be a survival of the times when most, if not all, the Cephalopods had an external shell like the Nautilus of to-day. Thus the little *Spirula* and its relatives

may be looked upon as all that remain of the swarms of Ammonites, some of gigantic size, that filled the seas of bygone ages, and whose remains are so common in the geologic strata of this country. Several other Cephalopods have been recorded from Cornish waters, but mostly as of not very frequent occurrence.

A conspicuous feature of the animal life of the beaches is the bird-fauna, representing which there are usually several species of waders, or shore-birds, besides the ubiquitous gulls. These must always attract the idler's attention, and by their pretty ways and lively habits will afford him plenty of amusement.

Though, of course, the various species of seaweeds cannot grow on the sand itself, they do so where ever a sunken rock offers a firm hold ; while many kinds are always to be found stranded on the beach or afloat in the shoal waters. These offer their own interest ; indeed, sometimes deep water kinds not to be found growing on the rocks of the coast may be picked up on the sands.

A minute examination of the finer and more packed sands of the lower beach would reveal the presence of innumerable minute green unicellular organisms that are known as Diatoms, and which also belong to the *Algæ*. A sort of greenish slime on the surface is also formed by masses of these microscopic plant organisms, and these, it must be considered, form the true plant life of the open beaches, since they alone can live and grow there.

The shoal waters of the Cornish coast is the home of the peculiar little fish-like creature known as the Lancelet, whose scientific name is *Amphioxus lanceolatus*, and which was originally described by Pallas from Cornwall. About an inch-and-a-half to two inches in length this little creature is not really a

fish, but represents a very much more primitive stage in the evolution of the vertebrates. It is even more primitive than the Tunicates, or Sea-squirts, which are explained elsewhere. As its name suggests it is lance-shaped, in fact it is not unlike the larval *Leptocephalus* of the eel in appearance. It is colourless and more or less transparent in life, and possesses eyes, olfactory, and other organs in a very primitive state of development. It burrows into the sand during the day, where it lies with its mouth exposed, the fringe of little ciliate rods that surround this organ keeping up a current of water, whence its food in the form of minute organisms is obtained and the gills are supplied with oxygen. At night the Lancelet leaves the sand and swims about, but returns quickly to cover at the least sign of danger.

The Sand Launces, or Sand-eels, of which two species, a greater and a lesser, occur along British coasts, frequent shoal waters, in such places as Mount's Bay ; and when in danger from the larger fish that prey upon them, seek shelter by burrowing into the sand. Of the two species the larger, *Ammodytes lanceolatus*, Lesauvage, is the less common, the Lesser Sand-Launce (*A. tobianus*, Linn.) being very abundant. The latter is frequently taken at such places as St. Ives in larger numbers in sein nets for use as bait. Both species are slender, silvery fishes with pointed snouts, long dorsal and anal fins, and forked tail fins. In the larger species the jaws are longer, and the fish attains a length of from twelve to fourteen inches, while the smaller form measure about half that length. Both the species have the habit of burying themselves in the sand as the tide goes out, indeed, it will be found that many marine animals do this, amongst others the common shrimp.

Two other fish which inhabit sandy bays and are

prone to bury themselves in the sand are the Weevers, of which the Greater is known to science as *Trachinus draco*, Linn., and the Lesser as *T. vifera*, C. & V. In these the mouth is upturned and the eyes set high up in the head, while both are armed on the sides of each gill-plate with a sharp poisonous spine capable of inflicting a very painful wound.

Besides these fishes there are two gobies that inhabit coastal waters on sandy bottoms, and are to be looked for in shoal waters, or shallow pools left behind by the tide. These are the so-called Rock-Goby (*Gobius niger*, Linn.), and the Freckled Goby (*G. minutus*, Linn.), little fishes with rather swollen depressed heads, and cylindrical tapering bodies.

It will thus be seen that the beach has its animal and plant life as well as the rock-pools. It only requires searching for, and when found, as it must be by the diligent seekers, it will amply repay investigation. It will be found that the different environment calls forth a different response on the part of the organisms. New subterfuges to meet new conditions are to be found. Most of the creatures, it will be noticed, have the means of burying themselves in the sand ; most of them are colored so as to match the sand ; there will be none of the brilliant colours that were noticed in the rock-pool animals. They survive the periods of low tide by burying themselves in the wet sand, quite a different method from such animals as the winkles of the rocks, who pull to their little door, as it were, and lie snug within their thick shells for days if necessary. And so we could go on citing instances but enough has been said to show the reader what he may look for in the way of animal and plant life on the apparently barren sands at low tide.

CHAPTER IV

HEADLAND RAMBLES

“The cliff-top has a carpet
Of lilac, gold, and green;
The blue sky bounds the ocean,
The white clouds scud between.

“A flock of gulls is wheeling
And wailing round my seat;
Above my head the heavens,
The sea beneath my feet.”

THE sun was shining over head with all the soft warmth typical of a summer's day in Cornwall. The sky was cloudless, though low down upon the horizon a sort of haze blurred the usually sharp line where the sky and sea meet. The sea was smooth as glass, except for an occasional cat's-paw where the lightest of zephyrs stirred its surface. Looking down from a dizzy headland we could see far, far below in the emerald green and crystal clear depths of the water purple rocks, round which large fish—pollack, or, perhaps, wrasse—swam lazily to and fro, or darted about as they chased each other in and out the long streamers of ribbon-weed. Between us and the sea lazy gulls, looking almost white against the rich colours of their background, circled, hovered, and then swung away, uttering their plaintive cries as they went. On the rocks that stood clear of the sea black shags could be seen, some with wings out-stretched, drying

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themselves in the sun after a bout of diving and fishing. A little distance out from the rock-bound shore both gulls and shags were floating upon the water's surface, or swimming listlessly about in search of food. There the sea had changed from emerald and jade to sapphire blue. In the distance, where a lovely cove broke the dark and rugged wall of rock, the whitest of sandy beaches dazzled the eye. Above it and beyond the cliff-tops showed a blaze of purple and gold, where heather and ling mixed in alternating patches with gorse and yellow vetch, the two tints gradually fading into one as distance lent its mauve and azure. Far beyond, less blue than the sea, but bluer than the horizon sky, the dim outline of other headlands completed the picture.

We were standing on the headland known as Logan Rock, so named on account of a gigantic stone, at once the pride of the natives, and the visitors, that is so delicately poised upon its rocky perch, as to be easily set a swaying by the efforts of a single man. The white beach was that of Porth Curnow, where the Trans-Atlantic cable takes the sea, and the distant headland Polostoc Zawn. We were making a tour of the "Five Lions," and a glorious day it was for a nature ramble.

It is many years since I first began the practice of taking long rambles into the country "for to admire and for to see" what Nature in her many moods lays out for the inspection of those who have eyes to see. In those days my happy hunting grounds lay in the Thames Valley, and later in the West country dales and dingles of the Avon Valley round Bath and Bristol. There was no particular object beyond the prying into Nature's secrets, and, perhaps, the gathering of a few of the more

interesting plants and animals for a closer study at home. The charm of those walks grew : they became a very large and important part of my life. At the first school I attended no interest was shewn in nature study, but when later at another school Botany and Zoology, taught by sympathetic teachers, were begun, the nature rambles received at once a fresh impetuous and a new significance. The days when school work was all dry cramming, when little was done to make a study of interest to the young people, are gone. Nature study, country rambles, and field work are now the order of the day. What I did for myself in those days, the path to happiness that I blazed, often meeting with open opposition and discouragement, is done and mapped out for the children of to-day; but even so it is not enough. The young minds of our children are eager, expectant, ready to seize upon anything of interest, and who shall deny that one of the sanest, healthiest, and even most useful subjects that can be offered to them is the study of nature. Adults to-day may have outgrown their youthful taste for such things ; but let them hark back in their minds to the days when they were boys and girls, and there re-discover the interest that living things had for them. In my case the country rambles of my school days have had a most marked effect upon my whole career. To them I mainly contribute the fact that I have become a field-naturalist and collector, an explorer in foreign lands. The smiling valleys of the Thames and Avon were exchanged for the boad reaches of the Yellow River and the forests of the Amur basin. The dingles and hills of the West country for the mighty canons and rugged peaks of the mountain masses of north and west China. Yet in all

my journeys and wanderings nothing quite like the Cornish headlands was seen; in many sea voyages no waters so clear, so green, so blue, as those round the Cornish Peninsula, unless it be those of the Inland Sea of Japan, or of Puget Sound, near Vancouver. It is a far cry from Eastern Asia to the western-most spur of England, but one cannot view one wonder of nature without making a mental comparison of it with another; while new scenes and surroundings are for ever calling up the old. The reader must therefore forgive me this digression from my task of describing a day with nature in Cornwall.

To resume, on the day in question we had come from Penzance in a great motor char-a-banc, one of those fine knights of the road that are helping to make the beauty spots of the British Isles known to their people. A bronzed, blue-eyed, lean-visaged son of Cornwall, a fisherman by profession, and a humorist withal, acted as our guide, pointing out places of interest and note to the accompaniment of shrewd remarks.

But Sonny and I had little time to spare listening to the guide—we were truant tourists if the truth must be confessed, for on every hand on those wonderful headlands that we visited that day were objects of the most absorbing interest. There were dense thickets of stunted gorse, ablaze with yellow flowers. There were wide stretches of heather and ling, both in full bloom. There were hummocks of thick-matted Sea-pink (*Statice armeria*), like great green pin-cushions studded with blossom-tipped hat-pins. Through the furze-patches ran tunnels into which startled rabbits bolted at our approach. Wheatears, larks, and stonechats chased their winged prey over the scrub. Lizards, belonging



(Photo by Gibson & Sons, Penzance.)

The Logan Stone, a delicately-poised rock that a man may swing : the formation here is of coarse granite.

to the genus *Lacerta*, darted to cover from the rammifying paths where they had been sunning themselves with their bodies flattened out to catch all the rays possible. Grasshoppers, green as grass, might be seen, jumping out of our way, or singing by the vibration of their large hind legs against their wings as they clung to some slender stem or stalk. Beautifully banded snails—pink or yellow with dark brown bands—might be gathered from the soft turf between the gorse-patches. Humble Bees droned over the heather and ling, gathering nectar from the elfin cups. All these things had to be investigated. They wanted a careful attention which left no time to listen to the guide. What were the exploits of a certain young naval officer, poets' nephew though he be, with the Logan stone, compared with the interest of the living plants and animals all round us !

We climbed upon the Logan Stone and were duly swayed—an eerie enough sensation in all truth—but the composition—a coarse kind of granite—of that same stone and of the rocks of the neighbouring cliffs appealed to us far more. Sonny, it must be explained, is consumed with an absorbing passion for stones, and his pockets are always full of specimens which show some peculiarity of structure or colour. Perhaps it is a little cavity full of shining crystals, or peradventure a small fossil shell marks the fractured surface.

From Logan Rock we went to the Land's End, where two delightful hours were spent roaming over that most enchanting of all headlands. Here the gorse is very stunted, standing no higher than the heather and ling, both of which are in great abundance. But a new entrancing floral feature is added in the wide-spread presence of the Kidney

Vetch (*Anthyllis vulneraria*), a small herbaceous plant that grows thick heads of yellow, or orange, sweetpea-like blossoms. Normally the flowers are yellow, but one of the plants' characteristics is that they show considerable variation, orange, red, and even mauve blossoms occurring; and it is in Cornwall that this characteristic is most prevalent. The effect of the dwarf gorse, heather, ling, and vetch all standing about the same height from the ground, is that of a fine Persian rug, rich with all the colours of the Orient.

The rocks of this headland, as they face the sea and receive all the moisture with which the west winds are laden, are covered with thick beards of a filamentous lichen, grey-green in colour, long and pendent in habit of growth. It is the sort of thing one sees in dank woods and forests, clinging to the tree trunks and mouldering branches. The dual nature or composition of lichens must be told to my young companions as we examined this peculiar growth clinging to the rock surface, where, one would think, no nourishment was to be obtained. As a matter of fact it is just its wonderful dual nature, this marvellous symbiosis of alga and fungus, that makes the complex called a lichen able to live and thrive on such a barren site. Such a phenomenon never fails to raise my wonder. That two distinct forms of plant life, one, by the presence of the substance called chlorophyl in its cells, capable of obtaining carbonic acid gas from the air and converting it into starch, yet, because of the absence of roots, incapable of obtaining nitrogenous substances from the soil, the other able to obtain nitrates, but, owing to the absence of chlorophyl, unable to build up starch—that two such plants should by some strange agency, have come together,

and, by a close association, each supply the other with what it needs and cannot of itself acquire, and together form a third and very characteristic plant, sufficiently so to call a species, is a mystery that requires more than the *chance* theory of evolution to solve. It suggests with irresistible force the presence of an intelligence in Nature ; something very different from the mere workings of chance. It might have been chance that introduced the first algal and fungoid spores to each other, with the resultant mutual benefit association of the two growing filaments, but it must have been something more than chance that seized upon the fortuitous circumstance to establish a new and definite species.

The world of animate nature is full of examples of symbiosis, or the mutual inter-dependence of two living forms to the benefit of both, but none are quite so striking as that of the lichens. Many people would call such a growth as that on the rocks at the Land's End a moss or fungus, never dreaming of the innate marvel of the thing, or for one moment guessing that it represents two different types of plant helping each other to live where neither of them alone could exist. A point to be remembered is that in the animal and plant world there is a considerable shortage of room, and that, apparently, is why so many different methods of existence must be devised. The lichens have solved the problem of how to live on a bare rock-surface.

At the Land's End there were more sea-birds than we had seen at Logan Rock ; the islands standing out of the sea, now troubled and restless in the swell of the Atlantic, were dotted over with the white forms of many kinds of gull: the lower more

rounded rocks, such as had been worn smooth by the troubled waters, were black with shags and cormorants, at least, one supposed that the larger, heavier birds were cormorants, though at that distance one could not be quite sure till a pair of binoculars revealed the white about their heads and the white spot on the side of the rump. Kittiwakes, herring gulls, and large black-backed gulls wheeled overhead, screaming, and even "stooping," after the manner of falcons, at the dogs that accompanied some of the visitors.

It is merely repeating a common-place, to say that there is nothing quite like the scenery of the Land's End anywhere in the country, nor, considering all that has been written upon the subject by distinguished men of letters, would one care to embark upon a description of so famous, one might almost say, so awe-inspiring a spot. By some it has been considered disappointing, why it is difficult to understand. It has been the subject of innumerable pictures painted by artists, famous and otherwise. It inspired Turner, as well as Ruskin. To me it seems that this, the uttermost part of England, the veritable end of our land, is exactly as it should be, high, rugged, precipitous, deeply cleft, fringed with fantastic and multiform island rocks, sprayed by grey sea mists and spume, pounded by the great, rolling surges of the Atlantic, whose angry, foaming waters boil with rage at their impotence to tear down those mighty ramparts, the outer walls of our kingdom.

At Gurnard's Head our ramble was continued, and there to our huge delight a stoat was seen to dart across a stretch of grass in front of us. A stoat is not often to be seen in broad daylight, but there was no mistaking this one as it bounded over

the sward in characteristic fashion, back arched, head half erect, and short, bushy tail straight out behind. It vanished into a hole in one of the low stone walls or dykes that serve to mark the boundaries of the fields in this part of the country instead of hedges. And what picturesque things these same broad dykes are, with their covering of turf, wild thyme, and other small rock plants, their dwarf ivy creeping over the stones of which they are built, their moss-filled crevices and their bunches of ivy-leaved toadflax, whose pretty little purple flowers exactly resemble in shape the snap-dragon of our gardens. A careful search in the crannies between the stones reveals several kinds of land shells, such as the common garden snail, the brown-lipped snail, and, lower down nearer the foreshore, the pointed snail and the banded snail.

One cannot go into details of all the many forms of animal and plant life to be met with in such rambles as those provided by a trip round the Cornish Peninsula, but mention must be made of one other class of interesting animals encountered by us upon one of these rambles. It was in a gentle rift above Kynance Cove in the vicinity of the Lizard, that we came upon a viper, resplendent in a new coat of brown and black, the characteristic zigzag line of black down its back telling us very plainly what it was. No one should ever mistake an English viper when he sees one ; the black line should warn him instantly ; yet ardent naturalists have been known to seize such a reptile with their naked hands, mistaking it for the harmless ringed snake, and, of course, paying the penalty of their rashness. Such a mistake is really unpardonable, for the ringed snake displays two very marked white or cream-coloured patches just behind the

head. In any case a quick, deft blow across the back of an escaping serpent will arrest its flight, and give the student time to make sure of its nature before he commits the indiscretion of picking it up. Our specimen was dealt with in this way, and became, in due course, part of our natural history collection.

This leads us to the question of the reptiles generally, and those recorded from Cornwall in particular. Mention has already been made of the lizard, specimens of which were seen by us. Those we saw were of a green colour on the sides. Particularly was this noticed in the specimen which we watched for quite a little while in the Kynance Cove vicinity. Were it not for the fact that doubt has been entertained as to its occurrence in Cornwall I should have identified these specimens as belonging to the species *Lacerta agilis*, Linn., the Sand Lizard. Yet they could hardly have been Common Lizards (*L. vivipara*, Linn.), for that reptile is brown. The sand lizard has been recorded, or at least included in the Cornish list by some authorities, and, judging from my own experience, I am inclined to the view that they were correct. Unfortunately our failure to capture the specimen we watched so closely makes it impossible to clear up the point. The common lizard is admittedly widely spread and common in the county. In this species the young are not hatched from eggs, but are born alive; hence its specific name. Both this lizard and the viper, whose scientific name, in this country, at least, is *Vipera berus*, Linn.—though by some the generic name of *Coluber* is held to be the correct one—as well as the Common Frog (*Rana temporaria*, Linn.) are interesting on account of their extraordinarily wide range. All three extend from the British Isles right across Europe and

Siberia to the Island of Saghalin in the Sea of Okhotsk at the mouth of the Amur River, specimens taken in the latter island being indistinguishable from others taken in Great Britain.

In conclusion it may be stated that the Ringed, or Grass Snake (*Tropidonotus natrix*, Linn.) is said to be not uncommon in Cornwall, where also the Common Todd (*Bufo vulgaris*, Linn.) occurs generally, and the little Webbed Newt (*Molge palmata*, Schneid.) is said to be common in places, as also is the well-known Slow-worm (*Anguis fragilis*, Linn.).

CHAPTER V

SUBMERGED FORESTS

FEW people living in the British Isles in these days of great industrial development can fail to have had their imaginations stirred and their interests awakened by the magic word coal. Coal has made Great Britain. Without coal she could never have attained the proud supremacy of sea, and in the world's commerce that she has enjoyed in the past, and, please God, and, with the united efforts of her workers and thinkers, will continue to enjoy for centuries to come. Without coal the British home could never have been what it has been, or become the symbol of all that is best in a nation, that can proudly claim to have set the pace and an example for the rest of mankind.

We all know that a seam of coal marks the ancient site, and is all that is now left of the once extensive tropical forests of some long vanished river delta. There, in the dim red dawn of things, giant ferns, horse-tails and other cryptogamic plants, the primitive ancestors of our present day varied plant forms, flowering and otherwise, grew in indescribable abundance and profusion. The steaming warmth of the climate of those days was productive even in northerly regions of a plant growth such as is only to be found now-a-days in the tropical forest belts of the Congo Valley, of the Malay Peninsula, and neighbourly islands of the Pacific and of the central portion of the Americas.

We all know that by some means these masses of vegetation were covered by deep deposits of sand or aluvium, and during the passage of immense periods of time, and under the enormous pressure of the superimposed strata, were gradually compacted and transformed into coal. But that was all so long ago, and the narrow seams of coal are now so remotely removed from any semblance of the primordial forests they represent, that the wonder of their origin is liable to have but little meaning for us.

It is therefore of more than a little interest to discover on the shores of our own country, under our very noses, as we laze through the hours of a well earned holiday, coal in the making! Not, it is true, on such a scale as just pictured, but sufficiently demonstrative to make us realize how our coal beds were formed.

I refer to the numerous submerged forests that fringe the coasts of this little group of islands of ours. All round the British shores the dead trunks of trees, representing bygone woods and forests, are to be found, sometimes lying in deep water, sometimes even occupying sites between tide marks. And of all these woodland relics, one of the most accessible, and by no means the least, is that of Mount's Bay on the South Cornish coast.

In these submerged forests, with their bits of blackened, softened branches and gnarled tree-trunks, half or almost wholly buried in the shifting sands, is wrapped up enough science and philosophy to fill a book, but two lines of thought and investigation in regard to their existence present themselves more insistently than the many others, and these are what they tell us of the past, and the guide they are to us of the inexorable future.

Wandering at low tide from the most seaward rocks that lie below Penzance along the wide, sandy beach towards Marazion or St. Michael's Mount, one comes before long to a place where lie what in the distance looked like low, flat rocks, but which, on closer examination turn out to be something very different. Rising in low irregular masses just a little above the sand is a peculiar dark brown substance, unlike any of the rocks one has grown accustomed to along these rugged coasts. It looks soft, yet water running over it seems not to scour it, as one would expect in the case of any soft substance. Stepping on it, one finds that it gives in a spongy, springy sort of way. It is neither mud nor clay, yet a stick poked into it sinks as far as one cares to thrust it.

What is it ?

With a stick it may be flaked up in rough-edged masses, and an examination of those edges reveals the presence of small half-rotten twigs, stringy bits of half-decayed roots, moss, and blackened hazel nuts.

Debris washed down from the hills by the streams and deposited in the bay ?

Not a bit of it. It is rich, rank, twig-filled leaf-mould, such as is deposited in every forest and the explanation of its presence thus on the beach covered by each successive tide, as it flows and ebbs, is that here in very sooth once stood a noble forest of oak, and elm, and hazel. Further proof lies at hand, a little nearer the tiny breakers that mark the incoming tide, for what in the distance appeared to be low-lying, black rocks, partially covered with slippery green seaweed, turn out to be the actual trunks of bygone giants of the woodlands ; not trimmed and dressed timber, the ribs of some

unfortunate ship wrecked in years gone by, such as occur in some places on our shores, nor yet remnants of some ancient groin ; but gnarled and twisted oak, in the rough, and, but for its prone position, just as it grew centuries ago, when the sea lay far to seaward of its present position, and Mount's Bay was a woodland valley.

The larger sections of this sodden timber are immovable, whether by their own weight or through being half buried in the sand, or because their roots still hold, does not appear ; but smaller branches as thick as a man's arm, or thicker, that have broken away from the parent tree, may be prized out of the sands, stood on end and examined.

Almost black, soft, yet in some cases still tough enough to resist one's efforts to break off pieces with the naked hands, the wood is unmistakably oak and shows the grain of that finest of English trees.

But the marvel of it is that there are any such recognisable remnants of trees to be found in such a place so many centuries after the forest of which they formed a part became submerged. It speaks well for British oak. No wonder the old *Victory*, Nelson's famous flagship, is still afloat. No wonder British ships swept the high seas, and carried the emblem of England's greatness throughout the world !

The thought carries us back to the days when British Ships, with British seamen—some of them men from this very spot on England's coasts—met and put to flight the great galleons of the Spanish Armada ; back still further to the days when our forefathers in their wonderful long-boats earned the dread name of Sea-wolves ; back to the time when the half savage British used only small

coracles, and put out not to sea in search of plunder, but hid, rather, from the overseas invader, in these very oak forests, perhaps, before they became buried beneath the sea ; back to the days when the Phœnicians first bartered with these early Britons of the Cornish Peninsula for tin ; back to the Neolithic age and the men of the Heliolithic Culture and their kist burials, their cromlechs and dolmens, the remains of which are scattered throughout our islands and are particularly abundant on the Cornish downs ; back to Paleolithic man, of whose life and culture we are only just beginning to understand a little ; back, even, to Eolithie man, of whose life and culture, if he had any, we really know nothing at all. At some time, probably rather later than earlier, in this long span of history and pre-history, the fallen, sodden trunks, that we have been examining in the sands of Mounts' Bay, were living, growing trees, spreading their great branches, a shelter whereunder the great wild ox and red deer might lie in the noonday heat, and dropping their golden acorns in the autumn, food for the wild boar. It does not appear certain just when these forests became finally submerged. Undoubtedly the process was a very slow one, and took place during an immense passage of time, though, to judge from certain historical documents, some of the trees still stood, forming a wood round St. Michæl's Mount, in the days of Edward the Confessor. The guide book also tells us that William of Worcester in his day wrote to the effect that St. Michæl's Mount was originally surrounded by a thick wood, six miles from the sea, and afforded finest shelter to wild animals.

As a matter of fact geologists have ascertained that in regard to Cornwall there is evidence of a

(Photo by Gibson & Sons, Penzance.)
The blackened remains of oak-trees buried by the sea centuries ago, reminders of the day when Mount's Bay was a woodland valley



considerable amount of vertical oscillation of the land of which this tail end of England is composed ; that is to say, at times seismic or other deep seated and fundamental forces have caused an uplift of the whole, or part, of the Peninsula, at other times a subsidence. Submerged forests as well as elevated beaches occur in many places round the Cornish coast, some of the former on examination having yielded remains of animals, such as deer and oxen, whales and marine shells. The mammoth (*Elephas primegenius*), the Reindeer (*Rangifer tarandus*), the Wild Horse (*Equus fossilis*) and the Cave Lion (*Felis leo spelæa*) have also left their remains in Cornwall. These became extinct long before the dawn of historic times in our islands ; in fact they carry us back to the great ice age and Paleo-lithic man, when the whole of England north of the Thames Valley was probably part of a great glacier.

It is impracticable to examine to any depth the layers, or strata, of a submerged forest such as the one under discussion, situated, as it is, between tide marks and the under sea ; but fortunately others occur, now lying some little distance inland, but still below sea level, which, to judge by the presence of layers of sea shells, must have been formed in exactly the same way as that of Mount's Bay. These have been examined in detail and to a considerable depth, and they have yielded besides the bones of deer, oxen and whales, marvellously preserved moss, hazel nuts and leaves, the shells already mentioned, and, in their upper layers, pile logs placed there by human beings. Indeed, in two of these buried forests at Carnon and Pentuan human skulls have been found at a depth of over 50 feet below the present surface. These have been

referred to the Neolithic age, which suggests that our forests became submerged in comparatively recent times.

It is not surprising, then, that none of the woody remains show any resemblance to coal. Far longer periods and far greater pressure, brought about by the accumulation and superimposition of far greater deposits, are required before coal, even of the softest and most bituminous, can be formed. After all, all we witness in the submergence and burial under the sands of the Mount's Bay forest, is just the very beginning of Nature's coal manufacturing process. At Pentuan and Carnon a stage further is reached in the buried forests there. These were first covered by the sea, which was afterwards driven back, as it were, and its waters replaced by accumulations of debris brought down from higher ground further inland.

We thus see that these submerged forests are evidence of a pretty considerable subsidence of the land of the Cornish Peninsula in comparatively recent times, that is geologically speaking, just as the raised beaches show that at a very much more remote period an elevation took place.

This brings us face to face with another phase of our subject: the evidence that exists of the unstable condition of the Cornish coast line. Judging from the remains of certain animals found in various deposits in England, including Cornwall, it is evident that at one time our islands formed part of Western Europe, whose western shore lay well to the west of the Land's End. The English Channel was, at most, only a broad depression, or valley, with a river running down it, whose tributaries were the Somme and the Seine on the left bank and the Ouse, the Avon, the Exe and

the Dart on the right. This great valley continued above water probably till Post-Glacial times, when, owing to an extensive subsidence, it was inundated and became an arm of the Atlantic. It was probably about this time that the Scilly Isles were cut off from the mainland, and the submergence of the forests of Cornwall began. The evidence of these forests is that the gradual subsidence has continued steadily up to the present times, is, in fact, actually going on now. Indeed, but for the occasional reversal of the process that has taken place from time to time, and of which some of the more recent raised beaches form the evidence, it is probably that a far larger portion of Cornwall would lie to-day beneath the great rollers of the Atlantic.

And the future ; what is the future of this, one of the fairest counties of England ? It has been estimated that if things go on in the same way as at present, if subsidence, erosion of the coastline, and denudation of the uplands continue to take place at their present rate, in less than a million years all that will be left of Cornwall will be a group of small rocky islands, like the Scilly Isles representing the four or five granite masses that form the backbone of the present peninsula.

As a matter of fact this is probably a gross over-estimation of Cornwall's lease, especially when we take into consideration the fact that the whole of the English Channel has become submerged only in the Post-Glacial times, and since the close of the Paleolithic age, that is to say, during a period of about fifteen thousand years, perhaps a little more. However, it makes little enough difference to the Cornishmen of to-day, or of generations to come, whether the period is a million

or only ten thousand years ; in fact, it would probably not concern them if it were not more than a few hundred.

These great periods of time, are, after all, quite beyond our practical conception, nor would one trouble to discuss them but for the fact that the whole trend of modern scientific thought is to assign such æons of time to the processes of nature, as had scarcely been dreamed of in the not very distant days when Darwin startled the world with his theory of evolution.

And our submerged forest of Mount's Bay, the remnants of which we stumbled upon in our search for shells or crabs at low tide, serve in no small way to bring home to us something of the working of Nature. We all know the perishable nature of organic matter ; but when we realize that a small twig or nut, a few sprays of moss, or a glittering beetle, that lived and grew in the days of Edward the Confessor, may be found still intact, neither crushed out of shape, nor very materially altered in composition, in the ancient forest mould that lies to-day at the earth's surface, between tide marks in Mount's Bay, so are assisted in no small degree to a comprehension of how the infinitely more ancient vegetation of the coal measures survived the passage of time to yield in this, the age of industrialism, the energy we require for our own mighty works and inventions.

CHAPTER VI

PIER-HEAD FISHING, LUG-WORMS, AND POLLACKS

FOR those who by reason of the nature of their internal economies dare not hazard a fishing expedition upon the bay in a sail-boat, but nevertheless desire to indulge in that most fascinating pastime, there is always the end of the pier and the wily pollack.

Some there be, in a place like Penzance, which makes no pretence at being ultra-fashionable, who swagger down the side of the harbour and along the stone quay to this coign of vantage in all the glory of creel and five guinea rod, with silk lines, white bob-float, and every refinement that a fastidious angler can require, or the astute assistant of the local sports emporium can suggest. Others, and these, it may be noticed, are the more regular habitues of the pier-head, local residents and towns folk for the most part, carry something more serviceable in the way of rods and a bag. Still others, mostly small boys and callow youths, whose slender pockets will not extend to the acquisition of a proper rod, make shift with a long bamboo, some eye-screws and the cheapest of lines. Only in the matter of hooks and gut do they appear at all extravagant.

But, as far as our observations went, indeed, as it turned out from our own practical experience, there was little to choose, in the results obtained,

between the serviceable rods of the natives and the bamboos of the youngsters. Sometimes one, sometimes the other, seemed to have the advantage. The only thing that was no use at all, from a practical point of view, seemed to be the expensive rods and lines of the "swanky" visitor. These generally got trodden upon by the spectators, or, because of their long and whippy ends, somewhat uncontrollable in the crowd, their lines hopelessly tangled up with that of some small, but causative boy ; and in the end the stylish angler generally beat a discomfitted retreat without any fish. Not that the pier-head fishers were rude, far from it : it was the very awkwardness of the grandee and his swagger rod, making him feel uncomfortably conspicuous in a crowd of unobtrusive experts, that drove him off.

It was only in the nature of things that Sonny should want to fish. "What else do you come to the seaside for," he remarked, and since his mother joined him in the issue against his father's better judgment, who foresaw a watery end for the ten year old, there being no railing on the Penzance pier, it was decided that a-fishing we would go.

After watching the proceedings at the end of the pier during a couple of evenings, we decided that bamboos and ordinary lines would do for us ; so off we went to the ironmonger's shop, and for a small matter of six or seven shillings acquired the component parts of three very useful fishing rods and lines. The evening was spent in assembling them. We tossed for first choice, though there was little to choose between them, and the rods were duly appropriated and marked.

Next day, following the custom of the small boys, we waited for low tide, and then went digging for

lugs in the mud and stones left bare by the retiring waters in the harbour.

Now the lug-worm is a wily animal, very quick in his movements when danger threatens. Moreover, he has a precise instinct for the most difficult of stoney patches, where the digger finds it an arduous task to turn him out of his snug retreat and make prisoner of his person. He is of a dull reddish colour, with a greenish tinge down the back, having a head with two spiny jaws, and rows of compound appendages down either side of the body, each provided with short, pointed spines and a few short hairs. Rejoicing in the scientific name of *Neries cultrifera*, this lug belongs to the class *Chaetopoda*, or "hair-legged," and to the order *Polychæta*, or "many-haired." As a matter of fact it is not really a lug-worm, the true lug being a dark brownish-green, or blackish, fat animal, with branching gill-tufts of a rich red colour down its sides. Its name is *Arenicola marina*, and it is to be found in the lowest sand stretches after the tide has gone out. Its whereabouts may be detected by the little heaps of sand that it piles up outside its burrows. It, also, is a favourite bait with pier-head fishermen, especially at such places as Hastings, but at Penzance the natives seem to prefer *Neries*, which they call lug. If taken in the mud of the harbour-bottom it is called mud-lug, if from the debris and sand in the rocky areas, the rock-lug. *Arenicola* they, apparently, call sand-lug, for one must suppose this to be the species they refer to by that name, though the fact was not verified.

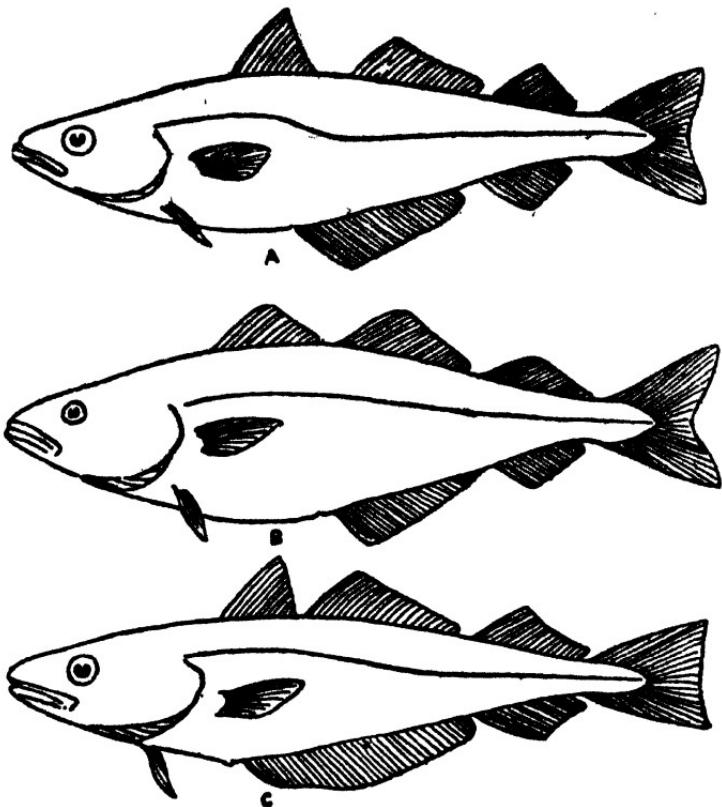
The rock-lug, whose scientific name is *Neries pelagica*, has the lateral appendages shorter and more simple than those of the mud-lug (*N. cultrifera*). Otherwise the two forms are very much alike. As

bait the rock-lug is not so good as the mud-lug, possibly being less rich in flavour and aroma on account of its cleaner feeding grounds. Anyhow, and whatever the cause, the pollack certainly favours *cultrifera*.

Our business was with mud-lugs, but we met with little success in capturing the elusive creatures, finally deputizing a local fisherman to do the work for us, giving him an honorarium of one shilling. To get the worms he requisitioned a trowel from a small boy, who, of course, required compensation. He was given a sixpenny bit, which he promptly lost in a puddle, and seemed quite hurt because he was not offered another. We were advised to keep the worms in a tin box lined with brown paper and half filled with some of the green weed called *Ulva*, or sea-lettuce.

That afternoon we went down to the pier-head, and, joining the little group of early comers, baited our hooks and proceeded to fish for pollacks.

The Pollack, it may be remarked, in case the reader does not happen to know, is first cousin to the cod, whiting and haddock, belonging, as it does, to the *Gadiformes*. Its classical name is *Gadus pollachius*, Linn., and it may at once be recognized by its very graceful form, rather pointed snout and protruding lower jaw, minute scales, and rich olive-bronze, or copper-bronze, colour. Like all the gadoids, except the hake, lings, rocklings and the fresh-water burbot, in which the vertical fins of back and ventral side are long and continuous, it has three dorsal and two anal fins. By this means these gadoids may at once be distinguished from all other fishes. The pollack belongs to a group in which there is no barbel on the chin, others of the group being the whiting and the coalfish.

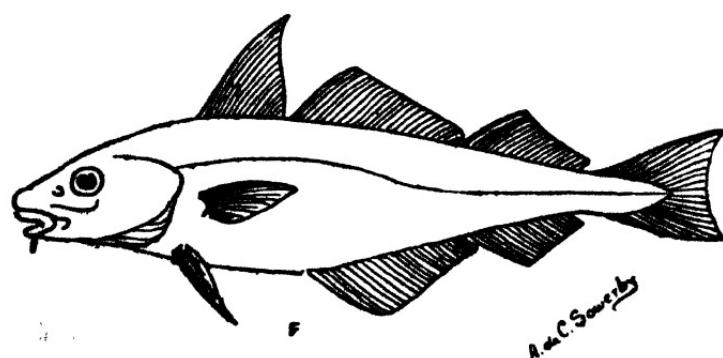
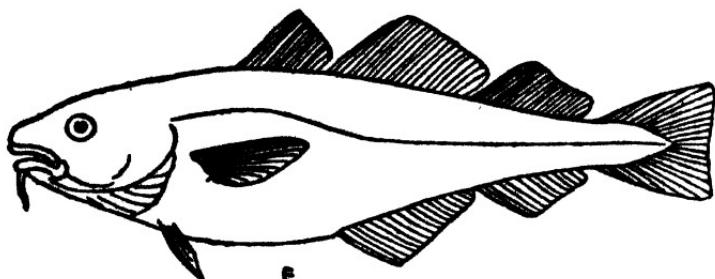
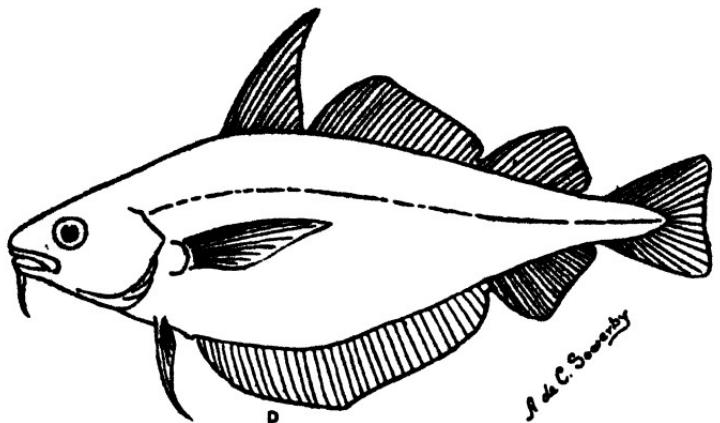


Some fish that may be taken with a rod and line from an open boat, or are common in the fish-markets.

- A.—The Pollack (*Gadus pollachius*, Linn.).
- B.—The Coalfish (*Gadus virens*, Linn.).
- C.—The Whiting (*Gadus merlangus*, Linn.).

A truly sporting fish it attains a good size and a weight of several pounds, though, of course, only comparatively small fish, a foot in length at most, can be captured off such a spot as Penzance pier-head. Young pollacks seem to keep to the rocky parts of the coast, remaining there till after their second summer, when they leave for deeper water. Those to be had off Penzance pier-head, of about ten inches in length, are in their second summer. For large fish it is necessary to go well out into the

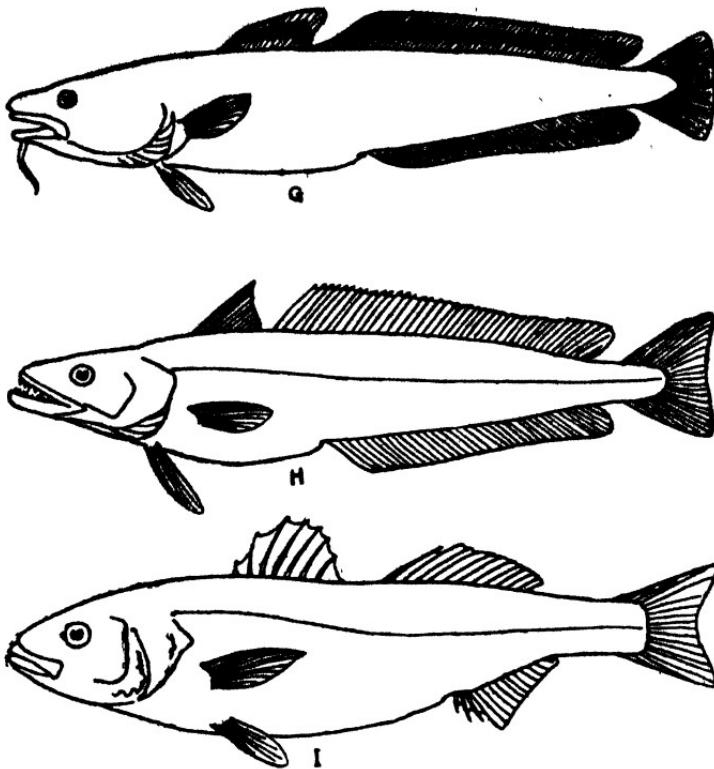
bay and fish with rod and line, or "wiff" with a line only, from a boat. According to the Badminton Library the record pollack weight is $24\frac{1}{2}$ -lbs. ; while Couch records one of 24-lbs.



D.—The Pollack (*Gadus luscus*, Linn.).

E.—The Cod (*Gadus morhua*, Linn.).

F.—The Haddock (*Gadus ogac*, Linn.).

G.—The Ling (*Molva vulgaris*, Linn.).H.—The Hake (*Merluccius vulgaris*, Linn.).I.—The Sea Bass (*Morone labrax*, Linn.).

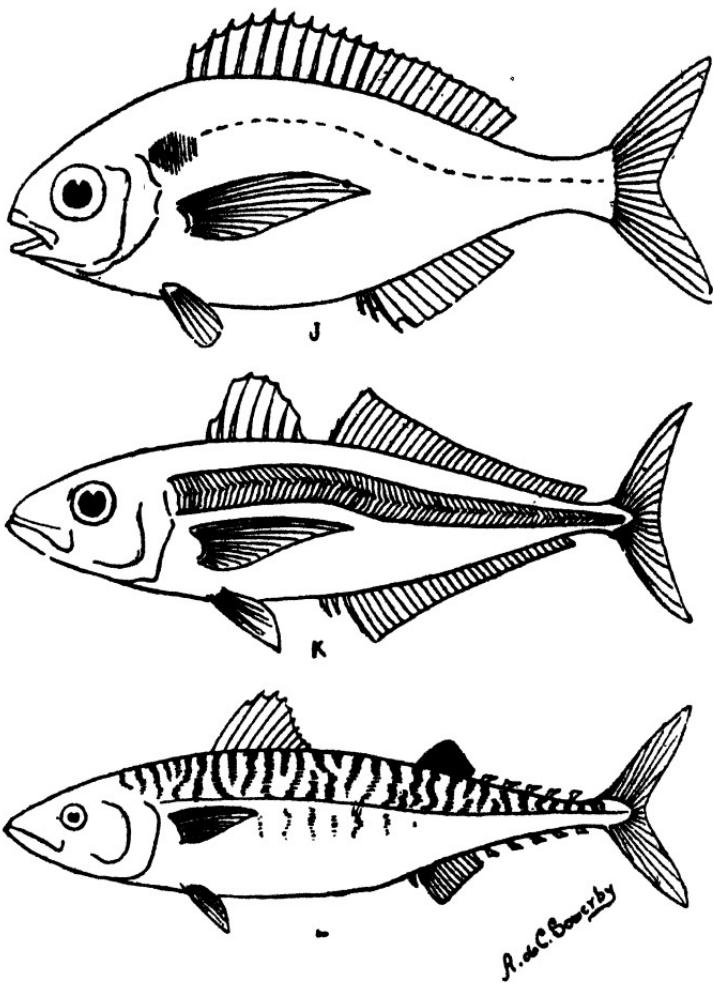
Whiffing, or fishing with rod and line from a boat in deep water is a favourite sport amongst anglers, and frequently, not only large catches are made, but also some very large fish are caught. Of course, such fishing has an additional charm in that several other species of fish are to be taken besides pollack. Indeed, the latter is often of only very secondary importance, especially when the far-famed sea bass (*Morone labrax*, Linn.) is to be had. This is a sporting fish of no mean order, and one any angler is pleased to capture. It is said to occur in Autumn and Winter so close in to shore as to be taken with a line off the sea wall at Penzance, and even from the

pier. Bass, also, reach a large size, Yarrell having recorded one of 28-lbs., and Day one of 22-lbs. The largest taken on a line is said to be one of 16½-lbs. Not unlike the pollack, but at once distinguishable on account of its shorter lower jaw, is the Coalfish (*Gadus virens*, Linn.), also to be caught in our district. It is not as good eating as the pollack, but is usually larger and heavier, the record being one of 32-lbs., mentioned by Thompson as taken in Belfast Bay. A fish of 20-lbs. was recently reported as taken at Fowey, in Cornwall. Bream, gurnards and gurnets, cod, conger and, of course, mackerel are also to be taken from an open boat, and for this form of sport Mount's Bay and surrounding waters are hard to beat, though, from all accounts Falmouth Bay is an excellent spot. In a recent issue of *The Field* (October 2nd, 1920) a catch of 536 fish of fourteen different kinds to two rods in twelve days is reported.

But to return to our pier-head fishing. It did not take us long to learn how to bait our hooks properly. A couple of succulent worms run on to a hook in such a way as to leave their tails streaming out seems to form an irresistible attraction to pollacks ; the larger the mouthful the better, up to a certain point, for then the bait will be taken by the larger fish. If insufficient bait is used the small fry will either seize it and get caught, or nibble it off before the larger fish can get it.

A little practise was necessary before the correct knack of drawing in the line could be acquired, but once this was learnt the rest, so to speak, was easy.

Naturally between the three of us there arose a spirit of rivalry, there always does on such occasions. The first competition was as to who should catch the first fish. The next, who should catch the most,

J.—The Sea Bream (*Pagellus centrodontus*, De la Roche).K.—The Scad, or Horse-Mackerel (*Caranx trachurus*, Linn.).L.—The Common Mackerel (*Scomber scombrus*, Linn.).

and then, who the largest. These points were duly settled, the honours being evenly divided on different days; nor could any of us complain of the lack of sport. It cannot be claimed for this sort of sport that much skill in landing the fish is required. Some might even consider that success is a mere matter of luck; but the close observer would notice that

certain of the habitues of the pier-head are nearly always successful, generally managing to make respectable catches, while certain others can catch little or nothing. The same close observer would note that time and tides are potent factors in the game ; that the method of casting and drawing in the line have something to do with it ; that certain spots on the pier are better than others ; and that the method of baiting the hook, and the kind of bait used are matters worthy of attention.

Thus, just at dusk, with a rising tide, we found to be the very best time of day for good results ; the best spot on the pier was just round the angle on the eastern corner, that farthest from the light-house ; and the best bait, as already explained, was the mud-lug.

One evening a regular visitor caught no fewer than two-and-a-half score of good sized pollacks. The news went abroad, and for the next few days, the pier-head was crowded with both anglers and spectators. It was a very genial crowd, and, what was best about the anglers, they were always willing to edge up and let just one more ardent sportsman into their ranks, till they sat and stood, elbow to elbow, packed like the proverbial sardines.

On a good day the total number of fish caught would run into several score, while it was seldom that each fisherman left the pier with less than from three to half-a-score of the beautiful and delicious fish for his supper or breakfast.

Very occasionally a scad, or horse-mackerel, or even a true mackerel would be landed. Not infrequently beautifully coloured specimens of the common wrasse, or conner, were caught. These were always killed and thrown back into the sea, as they

are considered unfit for food, and therefore a nuisance. The same fate was usually meted out, just why was not apparent, to the small specimens of the pout, a cod-like fish that inhabits the waters of rocky coasts, and which were not infrequently caught off the pier.

On the numerous afternoons that our little party devoted to pollack fishing we did very well, and when the weather became too boisterous, as it did towards the end of our stay, we passed, by unanimous consent, a resolution that pier-head fishing on the Cornish coast was no mean sport, at the same time registering a vow that we would lose no opportunity of indulging in it in the future.

CHAPTER VII

STRANDED WHALES

And God created great whales, and every living creature that moveth, which the waters brought forth abundantly

The First Book of Moses.

FROM time to time whales of various species get stranded on our shores, causing no little excitement amongst the local inhabitants and any visitors who happen to be in the neighbourhood. There are a good many records of such strandings, and details of these would reveal the fact that quite a number of different species are represented in the list, ranging in size from the Common Porpoise (*Phocæna communis*, Cuv.), which is really a whale, belonging to the *Odontoceti*, or toothed whales, to the great Blue Rorqual (*Balaenoptera sibbaldi*, Bell), belonging to the *Mystaceti*, or "whale-bone" whales, which runs up to as much as eighty-five feet in length.

Sometimes these strandings take place in the estuaries of our rivers, but more often they occur in shallow bays, where disporting and careless animals get caught by the rapidly retiring waters. It is not very long since a specimen of some form of whale was stranded in the Thames estuary, and the Mayor and Corporation of London set a heroic example of war-time economy to the nation by dining off whale-meat.

Some people might shudder at what might appear

a reversion to barbarity ; but from accounts in the papers of the banquet, the worthy city fathers appear to have enjoyed their novel repast.

But whatever is to be said for or against eating the flesh of stranded whales to-day, there is no denying the fact that to our primitive ancestors, the men of the old stone age, and even to those of a less remote date, a stranded whale was something in the nature of a godsend. In those far distant days whale hunting, simply for the flesh and blubber of these great marine mammals, when any of them approached sufficiently near to shore to make their capture possible, must have been an occupation of the greatest moment to the small coastal communities.

One can well imagine the exciting scenes as the half naked savages, from whom we are descended, armed only with bone spears or harpoons and flint-headed axes, waded in swarms through the foaming breakers to the attack upon some luckless monster of the deep, churning up the water and angrily thrashing its great tail-flukes in an endeavour to escape back to the open sea. One wonders how, with their primitive weapons, these same savages could manage to despatch so great an animal ; yet we may rest assured that despatch it they did, for the developing ingenuity of man, even in those remote days, would certainly not allow so much good food to escape. Already the human intelligence had risen superior to, and was conquering, its environment. The scenes that would follow such a capture can also be pictured by us moderns ; for there is still much of the savage hunter about it, especially those of us who can boast a Norse or a Celtic descent.

As a matter of fact, though Europeans, theoretically, at least, have progressed so far from the primitive whale hunting and eating state, there are still races of mankind on the earth to whom a stranded whale means as much as it did to our Paleolithic and early Neolithic forefathers. There is in the North Pacific Ocean a species of whale called the Grey Whale (*Rhachianectes glaucus*, Cope.) that literally hugs the coasts of Western North America and East Siberia, frequenting shallow bays and disporting itself in the surf, often where the water is not of sufficient depth to cover its long, grey body. This species is hunted and captured by the coastal Indians on the one hand and the primitive Tartars of the Okhotsk coasts on the other, and the methods used by these savages, for they cannot be looked upon as anything else, must be reminiscent of our own in the dim red dawn of our race. Only none of our ancestors could often have had to face so fearsome a monster as the grey whale, since the rorquals and other species that frequented the British coasts even in those days must have been, as from all accounts are their present day descendants tame and helpless compared with *Rhachianectes*. More accustomed to progression in shoal-waters, this whale is a formidable antagonist, and by furious rushes seriously endangers the lives of its attackers. Especially savage is a cow in defence of her calf, though, according to the accounts of eye witnesses, an old bull in defence of his mate may put up a big fight.

When the prey has been killed, and the great carcase lies stark upon the beach, a disgusting scene of flensing and gargantuan feasting begins, over which it is best to draw a veil.

The reason why the grey whale is mentioned here

in connection with the species that frequent our coastal waters, is because the remains have been found in comparatively recent superficial deposits in Cornwall—at Pentuan, near St. Austell, to be exact—of a whale named *Eschrichtius robusta*, Lilljebourg, that once inhabited European waters, including the Baltic, but is now extinct, and which in its skeleton development, at least, so closely resembles the Pacific grey whale, as to be thought by some to be identical. That is to say, in late Paleolithic or early Neolithic times the grey whale or a very closely related form, occurred off British coasts, and the fact that its remains have been found in deposits where human remains have also been found suggests that the early inhabitants of these parts must have hunted the monster much as the present day inhabitants of the Okhotsk coasts hunt the grey whale.

The latter may be described as a "whale-bone" whale with a rather small head and slender body, in which there is no "fin" on the back, while the folds on the throat are reduced to two only. The baleen, or "whale-bone," is short and not very valuable. It may at once be distinguished from the "Right" whales by its smaller head and more slender body, and from the Rorquals and Hump-backed whale by the absence of any dorsal "fin" or hump.

In historical times in England and Scotland, as well, of course, as on the Continent, the whaling industry has been one of considerable importance, and, one must suppose, stranded whales of some little value. At least there seems to have been sufficient value attached to the latter for the observation of some kind of law or custom regarding their ownership. No one who has read Sir Walter

Scott's "*The Pirate*," will have forgotten the scene wherein he described a stranded whale being attacked by the sturdy Shetlanders. The prize was claimed by one, Triptolemus Yellowley, the factor, as the rightful property of his master. Addressing the Udaller he says :

" Nay, sir—you know yourself, Master Magnus Troil, and everyone knows that knows anything, that whales of siccán size as may not be masterfully dragged on shore by the instrumentality of one wain with six owsen, are the right and property of the Admiral, who is at this time the same noble lord who is, moreover, Chamberlain of the isles."

And the Udaller's vigorous reply :

" And I tell you, Mr. Triptolemus Yellowby . . . as I would tell your master if he were here, that every man who risks his life to bring that fish ashore, shall have an equal share and partition, according to our ancient and loveable Norse custom and wont ; nay if there is so much as a woman looking on, that will but touch the cable, she will be partner with us. . . . "

There can be no doubt about these worthy men of the north valuing what the sea might send them in the way of whales, and, indeed, most accounts of the stranding of these creatures on North British shores give details as to the quantity of oil or baleen obtained from the carcases, thereby showing that full use was made of them.

A whale that gets stranded, possibly more often than any other on our shores is the so-called Pilot, or Ca'ing, Whale (*Globicephalus melas*, Traill), sometimes also called the Blackfish ; and it is the fact that, while staying at Penzance, we heard of the stranding of a large herd of these animals in Mount's



(Photo by G. J. von Son, Penzance)

The Pilot Whale (*Globicephalus melas*, *Tauall*) The two large leaders stranded

Bay some years ago, that has prompted the present remarks upon the subject.

No doubt the event was duly reported in the papers, but, being abroad at the time, I missed hearing of the somewhat extraordinary occurrence. The facts, as far as could be obtained by enquiring of people who witnessed the event are these :

One day in July, 1911, the town folk and visitors were considerably excited and interested beyond measure to see a large number of dark objects moving about at the surface of the waters of Mount's Bay at no great distance from the shore. It was soon evident that they were whales of some sort, and that the large herd appeared to be under the leadership or guidance of two large leaders. My informant was very insistent on this point, which is significant, for the very word Ca'ing means driving, and both it and the name Pilot have been given to this species because of the way the large leaders, apparently old bulls, herd and guide the large schools that accompany them.

The luckless whales that were disporting in the bay finally came so close in shore that they presently found themselves, as the tide went out, first in shallow water and then actually stranded. There were sixty-four of them altogether, and, according to my informant, they seemed very helpless and stupid. There they lay, some on their sides, some on their stomachs, occasionally flapping their long flukes. They appeared to make no effort to escape to the open sea, when they found the tide falling ; and even when later the rising waters refloated some of them, those that were not dead and were carried out to sea, actually returned again and again. The two leaders, which were a good deal larger than the others, did not, apparently, get floated off again,

and it was evidently the characteristic habit of these whales in blindly following their leaders, that caused those that did get the chance of escape to return to those they had lost, and ultimately to perish with them. At least, this is how it appeared to my informant, who seems to have taken a very intelligent interest in the phenomenon, albeit, as far as I know, not a trained naturalist.

At last all the great animals were dead, and then arose one of those curious contingencies that could only take place in law-abiding England. The question was, to whom did the whales belong, and because no one could or would answer the question, the carcasses lay on the beach till they became putrid, and their stench drove visitors and natives alike from the vicinity. Ultimately they were buried, no use having been made of them at all. On the Okhotsk coast, or in Scotland, or anywhere else in the world, almost, had such a thing as the stranding of many whales happened, somebody would have had them, of that we may rest assured, though not necessarily the rightful owner.

And very valuable such a harvest must prove to be, for a considerable amount of oil and sperm is to be had from the Pilot whale, and in more northerly latitudes, where this species occurs sometimes in herds of a thousand or two thousand individuals, if reports are to be believed, their appearance in any bay or estuary is a signal for a general mobilization of the local inhabitants in an attempt to surround by boats and drive ashore as many victims as possible.

But, after all, their monetary value is far from being the only interest, though to some it may be the greatest, that pertains to stranded whales. Men of science have always found them of considerable

interest and importance ; indeed, in many cases, the only reliable information has been obtained by the examination of such specimens. Few first class zoologists have been able to accompany whalers on their expeditions, whereby they might have learned much concerning the cetaceans, great and small ; and, were it not for the fact that these peculiar mammals, have so often in times past allowed themselves to be betrayed by the ebbing tide, and so give the naturalist the opportunity he seeks, our knowledge of many of the species would be very limited.

It is something over a hundred years since an ancestor of the writer, James Sowerby, the naturalist and artist, described his Beaked, or Two-toothed Whale (*Mesoplodon bidens*) from a specimen that was stranded on the Elgin coast in the year 1800. In this species the head is prolonged into a sort of beak, very different from the Pilot Whale, in which, as the generic name signifies, the head is peculiarly globose. In Sowerby's Whale, as it is popularly called, there are only two teeth, one in each lower jaw. The species is very rare, only twelve specimens having been recorded on British coasts, and not many more from other parts of North-western Europe. The last specimen recorded was one that was stranded at Rosslare, in Ireland, in 1914. It was sent to the Natural History Museum at South Kensington. The food of this whale appears to be mainly cuttle fishes and octopuses of some size, to judge by the white scars generally found on its body, and supposed to be left by the sharp, parrot-like beaks of these molluscs.

The food of the Pilot Whales, it may be mentioned, is said to be the same, but they are also known to eat fish, and it is probably in pursuit of such prey

that they venture into the bays and inlets where they so often get into trouble.

According to the records the latter species is of very infrequent occurrence in Cornish waters, it having been reported but twice before; while Sowerby's Beaked whale has not been reported so far south at all. The appearance, therefore, of the big herd of Pilot Whales in Mount's Bay in 1911 makes an extremely interesting record.

Most of the whales seem to prefer a more northerly range than that including the warm south coast waters of England, for which reason British records of cetaceans are more numerous on the northern coasts than elsewhere. For instance, the White Whale, or Beluga (*Delphinapterus leucas*, Pall.) from which is obtained the commercial product "porpoise hide," and the Narwhal (*Monodon monoceros*, Linn.) familiar to most people as the possessor of one, sometimes two, long, straight, spirally twisted tusks, have been recorded only from North British coasts, their true range being more arctic.

Altogether only eight species of whales have been definitely established as occurring on the Cornish coast, including two Rorquals, or Finner Whales, the Bottle-nosed Whale, two species of Grampus, or Killer Whale, the Common Porpoise, the Dolphin, and the Pilot Whale.

The Rorquals are "whale-bone" whales, that is to say, they have the teeth in the form of baleen, the substance commonly called whalebone, and formerly of considerable value. They are long and comparatively slender in form, have a tall "fin" on the back, and the outer surface of the throat and chin folded into numerous longitudinal grooves. The largest is the Blue, or Sibbald's, Rorqual, a specimen of which measuring sixty-five feet in length

was washed ashore at Cadgwith, near the Lizard. Next in size is the Common Rorqual (*Balaenoptera musculus*, Linn.), attaining a length of sixty-five to seventy feet. It is of a slate-grey colour above, white below; very different from the dark bluish-grey with white spots on the breast of the Blue Rorqual. Several specimens have been reported from Cornwall. These whales feed mainly upon the planktonic crustacean *Euphausia inermis*, as well as upon other species belonging to the plankton, and such fish as herrings.

Neither Rudolph's Rorqual (*B. borealis*, Less.) nor the Lesser Rorqual (*B. rostrata*, Müll.) have been recorded from Cornwall, though both have been reported from other places on the South and East coasts of England. Of these the former is of a bluish-black colour with oblong light-coloured spots above, and the underparts more or less white with the exception of the under surface of the flippers and tail. It is a regular summer visitor to the coasts of Finmark. It is said not to feed on fish at all, its food consisting almost entirely of the planktonic crustaceans, *Euphausia inermis* and *Calanus finmarchicus*. It attains a length of fifty feet, while its baleen, being longer than in the Common Rorqual, is of greater value. The Lesser Rorqual never exceeds thirty feet in length, and is of a greyish-black colour above, white below, including the under surface of the tail. The famous Sulphur Bottom Whale of the Pacific is apparently an eastern race of one of the larger Rorquals.

In the Middle Ages, according to authentic accounts, the inhabitants of the shores of France and Spain, the Basques, carried on an extensive whaling industry. The species they pursued was the so-called Black Right Whale (*Balaena glacialis*, Bonnaterre),

of which *B. australis* and *B. japonica* are closely related forms, some considering them mere varieties. This is a more southerly representative of the famous Greenland Right Whale (*B. mystecitus*). It is of a uniform black colour, and has a much smaller head and mouth than the latter, whose very long baleen rendered it of such value that it has been hunted by whalers to the verge of extinction. It is probable that the Black Right Whale occurred in Cornish waters in the long past days when it was plentiful off European coasts, but there appears to be no records of this.

One other baleen whale may be mentioned, and that is the Hump-backed Whale (*Megaptera nodosa*, Bonnat), characterized by a long, low dorsal "fin" and extremely long flippers and lobes of the fluke. It is a coastal species, specimens of which have been taken off Scotland and the northern coasts of England. In some ways it might be considered as intermediate between the Right Whales and the Rorquals, for it has the throat-grooves of the latter, which are absent in the former, at the same time being much less slender in form than the Rorquals. The anterior edges of the flippers and posterior edge of the fluke are peculiarly indented. In colour this species is black above, variegated black and white on the throat, chest, and flippers. Sometimes the latter are entirely white. It is represented in the Pacific as well as in the Atlantic, but whether by a different form, or not, is not quite clear. It is also known under the specific names of *boops* and *longimana*.

Of the toothed-whales, that is to say, those that have proper teeth, and feed regularly on fish large and small, and other marine animals, including seals and other cetaceans, the Grampus or Killer is worthy of notice ; being as it is, the wolf of the sea. This

terrible creature, measuring some twenty feet, about the same size as the Pilot Whale, is said to feed habitually upon warm-blooded animals, and is the special foe of all seals. It also attacks the helpless whale-bone whales, when a number of individuals join together and having killed their victim greedily devour its huge fatty tongue. The species is known to science as *Orca gladiator* of Lacépéde, and may easily be recognised by its very tall back "fin" and the extensive white markings on its black upper parts, its lower parts being white. Its powerful jaws are armed with numerous sharp, strong teeth, while its head and snout are more pointed than in the Pilot Whale.

The species known as Risso's Grampus (*Grampus griseus*, Cuv.) is not really a Grampus, being more nearly related to the Pilot Whale. It feeds upon cuttle fishes, like Sowerby's Beaked Whale, and not, apparently, on warm-blooded vertebrates.

But Bottle-nosed Whale (*Hyperoodon rostrata*, Chem.) attains a length of thirty feet, and may be recognized by the jaws and snout being produced into a sort of beak, its head otherwise being rounded somewhat as in the Pilot Whale. Like Sowerby's Whale it has only two teeth, but in life these are hidden by the gums. A specimen was brought into Polperro in 1850, which appears to be the only Cornish record, although the species is said to be one of the commonest cetaceans round British coasts.

The Common Porpoise (*Phocæna communis*, Cuv.) and the Common Dolphin (*Delphinus delphis*, Linn.), easily distinguishable from one another by the elongated jaws and snout of the latter, are the only other cetaceans recorded from Cornish waters with certainty, though Couch mentions both the Cachalot, or Sperm Whale (*Physeter macrocephalus*, Linn.)

and the Humped Blower (*P. polycyphus*, Jen.). He does not appear to have examined personally, or even to have seen, specimens of either of these himself, and there appear to be no other records.

(Photo by Gibson & Sons, Penzance.)

The Caves, Kynance Cove.



CHAPTER VIII

KYNANCE COVE, THE PALACE OF SERPENTINE

"And the rainbow hangs on the poising wave,
And sweet is the colour of cove and cave."

Tennyson.

N EARLY every visitor to Cornish watering places makes a trip at some time or other to Kynance Cove, far famed for its wonderful beauty. And very rightly so, for there is no more beautiful spot along the whole length of a coast that is noted for its loveliness, its bold and rugged beauty, the inimitable contours of its outline, the clarity and colours of its waters, whose magnificence when stirred to wrath by the master of storms, beggars description.

Kynance Cove combines in one spot all the charms of the whole vista of the Cornish coast-line. In fashioning this wondrous place Nature has transcended all her efforts at scenic production, she whose humblest work eclipses the best that man may do.

The praises of this enchanting spot have been so oft and so ably sung, that a description here might almost seem out of place. Yet, one cannot resist the temptation of adding one's own testimony to that of others, who have likewise been inspired by its sheer loveliness. The physical contours of the cliffs and rifts of this part of the bold promontory, known

poetically as the Lizard, the nature of the rocks that form them, their configuration and manifold colouring, the water-worn caves intercommunicating with each other by quaint galleries, the virgin whiteness of the sands, contrasting strangely with the deep rich hues of the rocks, the crystal-clear waters of the numerous bays and inlets with their sapphirine, emerald and amethystine tints, the dark pinnacles and islets that dot their shimmering surfaces, the floral beauties of the rock-ledges where the sea-pinks cling—all combine to

“ . . . speak of grandeur, that defies decay,—
Proclaim the Eternal Architect on high,
Who stamps on all His works His own eternity.”

A rugged and steep path descends from the flat plateau of the promontory to a smooth beach that is a miracle of whiteness. Here steep rocks surround one, black with a greenish tinge, shiny for all their roughness. Isolated blocks, stand out of the glistening sands, and at their bases lie pools as clear and as blue as the vault of heaven. The rugged cliffs run out into the sea, where their blackness cuts the jade-green waters with the sharpness of a knife. Passing between the rocks another beach is reached, fingering a charming bay, and giving a view of the boundless horizon ; while to landward is the mouth of a valley down which one might have come, had one preferred an easier path. To the left as one passes west—the Cove facing south—lies Asparagus Island, an island only when the tide is up, a peninsula else, and to the right are the caves. In front, cutting in twain the view of a second even more beautiful inlet is Steeple Rock, a towering mass of many-hued stone, unscalable, imposing in its solitude, capped with grass, a haunt of sea-fowl. Beyond, across the limpid waters of the bay loom, more

islands and sculptured cliffs, a labyrinth of fantastic rocks littering the shore at their bases.

And the reason for all this wondrous beauty? It is not far to seek. All scenic beauty is primarily dependant upon the nature and formation of the rock of which the country under view is composed; and what makes the whole of the broken coast-line of the Lizard, and especially such spots as Kynance and Mullion Cove, so enchantingly lovely is the fact that the rock formation is entirely, or almost entirely, of Serpentine, than which few stones, that occur in sufficiently extensive masses to give a special character to the whole country side, are more exquisite.

The whole of the southern half of the Lizard, the heel of the Cornish boot, with the exception only of a section lying on the eastern coast, which is of epidioritic and diabasic Greenstone and Gabbro, and the region of Lizard Point and Predanack Point, which are of Metamorphic rock, is of Serpentine, a mineral long known for its beauty and comparative softness, and valued accordingly for decorative purposes in the interior of buildings, as well as for the manufacture of ornaments.

Its softness renders it amenable to the sculpturing effects of the elements, particularly of the sea, yet, unlike many other soft rocks, it does not crumble away. Consequently it forms bold cliffs, graceful spires or isolated columns, while low down, where the surges work their wild will, deep tunnels, caves, and fissures, are hewn out of its substance. At one spot, indeed, on Asparagus Island, the waves have produced the peculiar phenomenon, known popularly as the Devil's Blow Hole, or Bellows, a tunnel with an opening in its roof, through which, when the waves roll in, water and spray are driven with the roar of artillery.

The caves, which, like many of the isolated rocks and islands, have individual names, might well have formed a palace for some chieftain of primitive man. Their polished sides, polished, that is, in comparison with what the surfaces of rocks in the open usually are, are of a rich red intermingled with black. From one, the largest, is a view of one bay and part of Asparagus Island, while the other two look out upon the second bay, with Steeple Rock in the foreground. Here might one lie upon the soft white sand and dream away a lifetime in contemplation of the entrancing scene, watching the sea-fowl and the nymph-like bathers that love and frequent this delightful spot. It is a place for summer dreams, for the poet and the artist, and for all who love Nature in her softer moods, and are content so long as their eyes rest on what is lovely, and their ears are filled with the rhythm of the lapping waves.

But it is not so much my intention here to describe the scenic beauties of Kynance Cove, tempting though they be, as to discuss the rock of which the place is mainly composed. After all our primary interest in these pages is in natural history, and surely there is a natural history of the rocks and of minerals as well as of living things. No naturalist of to-day can afford to neglect the all important science of Palæontology, which treats of the fossil remains of bygone animals and plants, through the study of which alone can we hope to understand and interpret the relationships of present day species with each other. Now can the Palæontologist neglect the sister science of Geology, which deals with the rocks in which those fossil remains are found, expounds their stratigraphy, tells how they came to be formed, whether as sediments deposited at the bottom of some ancient sea, or as more recent



(Photo by Gibson & Sons, Penzance)

Steeple Rock, a towering mass of many-hued stone, unscalable, imposing in its solitude, capped with grass; a haunt of sea-fowl.

fluvial deposits, calculates their age and the periods of their existence, explains much that, to the Palæontologist, would otherwise be obscure.

The Geologist in turn calls to his aid the Mineralogist, for he must know the composition of the rocks with which he deals before he can trace their origin. He must know the nature of the minerals that compose them before he can explain their affinities and their distribution throughout the earth's crust. For instance, it is only the knowledge that limestone is mainly Carbonate of Calcium, that gives the clue to its origin as a deep sea deposit formed by countless numbers of the shelly remains of dead animals ; that marble, being composed of the same material, though crystalline in form, must have had a similar origin, but was subsequently changed by heat and pressure till it assumed that crystalline form that makes it so beautiful.

The Mineralogist must know a great deal of Chemistry, and the Chemist, in turn, Botany and Zoology, since plants and animals are productive of so many chemical compounds that cannot otherwise be formed. We now have the comparatively new science of Bio-Chemistry, or the Chemistry of life, which neither Zoologists nor Botanists can afford to neglect—and so we could go on showing how each of the many sciences are dependent upon, or linked up with, many others ; but enough has been said to show justification for our departure, for a while, from the contemplation of animals and plants only.

As a matter of fact my young companion and I found the Geology of Cornwall a never failing source of interest, being almost as keen on specimens of rocks and minerals as we were on those of living forms. I am not at all sure that the lad was not

more keen on the inanimate products of nature, from which, as yet unrealized by him, the world of living creatures has been, in some mysterious way, evolved.

Thus we usually spent some time, whenever we entered a district with a new geological formation, in examining the rocks, and, if necessary, taking samples for the collection that we were making. Consequently the rock-formation at Kynance Cove was of particular interest to us, and since the beautiful stone Serpentine is so widely known and used in this country, the following remarks may prove of interest to the reader.

Serpentine, as a mineral may be described as a hydrated silicate of magnesium and iron, and has the chemical formula $3(\text{Mg Fe})\text{O}_{2.2}\text{Si O}_2\cdot 2\text{H}_2\text{O}$, which, put more simply, means that the elements magnesium (Mg) and iron (Fe) combined with oxygen (O) are intimately associated, if not actually in combination, with the compounds silica (Si. O₂), of which quartz is the pure crystalline form, and water (H₂O). Serpentine as it occurs in nature is generally the result of alteration by heat of a Peridotite, sometimes of a Pyroxenite. That is to say, it is a derivative through the action of great heat of previously existing rocks known as Peridotites and Pyroxenites. Of these the former are composed mainly of a mineral called Olivine (a silicate of magnesium and iron), of which the most precious form is the beautiful olive-green gem known to jewellers as Peridot, and the latter mainly of Pyroxene, the name given to a special group of minerals. Pyroxenite, it may be noted, differs from the Gabbros by the absence of Felspar, and from the Peridotites by the absence of Olivine.

The Cornish Serpentine is mainly derived from Olivine, that is to say, Peridotites.

The rock Serpentine is usually of a greenish colour, and is soft and easily worked. It gets its name from the fact that its beautifully mottled and streaked appearance has been thought to resemble the skin of a snake.

The purest form of the mineral is called Precious, or Noble, Serpentine, names given to distinguish the fine green, semi-translucent stone from the darker more opaque Common Serpentine. The former occurs in the rocks at Kynance Cove in veins running through the latter, and itself has a tendency to show red veining. It has a conchoidal fracture, and a hardness of between 3 and 4, while its specific gravity is from 2.5 to 2.65. A rather hard form, not Cornish, and known as Bowenite, has something the appearance of green jade, for which it is sometimes mistaken.

The Common Serpentine of Kynance Cove is of a dark greenish-black colour mixed with red in varying proportions. In some rocks, notably those in which the caves occur, the red is almost completely predominant; while in other places it is hardly to be detected, light and dark greens mixing with the black. Another form occurs in the district, in which the ground colour of the rock is greyish green, with veins of whitish crossing it in all directions.

When highly polished these various colours and markings are beautifully displayed in the rock; but the latter, even in its natural state, untouched by the lapidary, is of extreme beauty.

All the various forms are worked into ornaments by the natives of Cornwall, some of whom may be seen at work at Lizard above Kynance Cove. These

are sold to visitors, who may thus carry away with them both polished and unpolished examples of this many-hued rock, mementoes of the beauties of the Cove, which may well be called the Palace of Serpentine.

CHAPTER IX

CORNISH ROCKS AND MINERALS

Surely there is a vein for the silver, and a place
for gold where they fine it.

Iron is taken out of the earth, and brass
is molten out of the stone.

* * * * *

As for the earth,

The stones of it are the place of sapphires ;
and it hath dust of gold.

The Book of Job.

IN a preceding chapter the beautiful rock Serpentine was discussed, and, our interest once awakened, we are led by easy and natural stages to a consideration of other minerals and rocks that may be met with during a summer's holiday in the Cornish Peninsula.

I have already mentioned elsewhere the keen interest my small son always shows in stones ; and here I would make bold to say that many other lads, and grown-ups as well, could do far worse than pay some heed to the pebbles they tread underfoot, the rocks o'er which they clamber during their holidays, or the formation of the cliffs they scan as they recline on the beach by the sea-shore. As Kingsley has finely said :

“ Study geology, and you will rise up awestruck, and cling to God.”

Cornwall is extremely rich in minerals, and during our stay in the county we spent many an interesting

half-hour examining the rocks and stones that came in our way. The tin-mines of Cornwall are famous. Her copper mines are also profitably worked ; while "native" gold, silver, and copper have been found at various places.

There are also there certain gems, as well as many semi-precious stones, and numerous very beautiful minerals that assume lovely crystalline forms, but which cannot be classed either as gems or as semi-precious stones, though well repaying the investigator, whose cabinet they will grace. In addition to these, which may be found more or less sparsely distributed through the less beautiful rock formations, and many of which are brought to light only by the miners digging into the bowels of the earth, there are the rock-formations themselves, which are well worth studying.

Armed with a geologist's hammer and a good cold-chisel, the neophyte mineralogist may spend many engrossing hours, either in quarries, old or new, along the cliff-bottoms, or, best of all, round the heads of mines ; and by a good use of his eyes, he may soon gather together a useful little collection of minerals, including ores, rock-specimens, and groups of crystals.

CRYSTALS

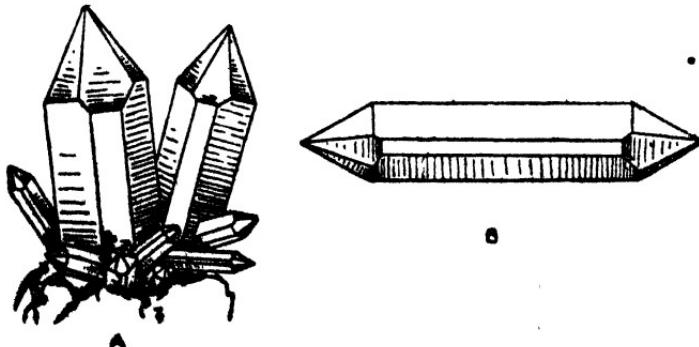
It is probable that the various more beautiful rocks and crystals that have an intrinsic value will at first appeal most strongly to the collector ; and of these the many and varied forms of Quartz, Silica, or Oxide of Silicon, whose chemical formula is Si O_2 , cannot fail to attract attention. Rock Crystal, Amethyst, Rose Quartz, Cairngorm, Jasper, Chalcedony, Bloodstone, Chrysoprase, Sardonyx, Onyx, Agate, Mocha-stone, Cornelian, and Precious

Opal are all forms of Quartz, the last being a hydrated quartz ; and some of them, notably Amethyst and Rose Quartz, are comparatively abundant in Cornwall. The former of these two may be found in thick encrustations of various sized crystals on quarried Granite ; while Rose Quartz occurs in large blocks and masses in granite outcrops.

The purest form of Quartz is Rock Crystal ; and it was to this substance that the name "Crystal," which means "clear ice," was first given by the Ancients. It was only later, during the Seventeenth Century, that the word was given a wider meaning and made to embrace all substances which take on certain definite more or less geometrical forms. Thus Rock Crystal may be considered the type of all crystals, for it was *the* original Crystal. This form of Quartz is found in Cornwall, notably at Tintagel.

The name "Common Quartz" may be used to denote the more or less opaque forms of Crystal that have received no other appellation.

The system of crystallization of Quartz is what is known as rhombohedral : that is to say, it consists of hexagonal prisms surmounted at each end with hexagonal pyramids. Rock Crystal and Amethyst



A.—Group of Quartz Crystals.

B.—Single Quartz Crystal.

show this very well, the latter, however, usually having the prism shorter.

In such kinds of Quartz as Chalcedony, Agate, and Flint, no crystalline form occurs, these being known as amorphous, or "without form." Some fine examples of Chalcedony are to be found in Cornwall. Bloodstone, also called Heliotrope, is a dark green mineral closely akin to Chalcedony, with spots of a blood-red colour in it.

Jasper is a mixture of Silica and red clay, and in its common form is to be found in Cornwall. It does not occur in a crystalline form, is hard, and takes on a high polish. This last fact and its frequently beautiful blood-red colour place it amongst the semi-precious stones. Indeed, it formed one of the twelve precious stones of the breastplate worn by the priests of Israel, which ran :—the first row a Sardius, a Topaz, and a Carbuncle ; the second row an Emerald, a Sapphire, and a Diamond ; the third row a Ligure, an Agate and an Amethyst ; and the fourth row a Beryl, an Onyx, and a Jasper.

It is interesting to note that five of these stones belong to the Quartz group.

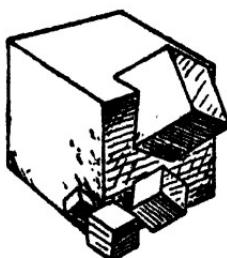
Passing from this group we may consider another very attractive mineral that occurs in Cornwall. This is Fluor Spar, or Fluoride of Calcium (Ca F_2). The system of crystallization of Fluor, is cubic, that is to say, the mineral occurs usually in the form of cubes. As Darwin says :

"His cubic forms phosphoric Fluor prints,
Or rays in spheres his amethystine tints."

These cubic crystals are arranged in groups and sets at varying angles in regard to one another. There is one beautiful group form assumed by the pale-green Fluor of Cornwall worthy of special mention. In this a large number of minute cubes

are assembled in the form of one large octahedron, or eight-sided crystal. But the basic cubic form of Fluor crystals is not always recognizable, for, what may be called the slicing away of the angles, with the consequent formation of new faces, often completely disguise it from all but the initiated. Suppose each corner, or solid angle, as it is called, of a cube were sliced off, the resultant figure would be one with fourteen faces, namely what is left of the six original faces of the cube and eight new ones, one at each corner of the cube. Fluor crystals with this formation occur in nature. Carry on the process by increasing these new faces in size, which automatically reduces the size of the six old ones, and at last the latter disappear and we have an eight sided figure, each of the eight sides or faces being an equilateral triangle. This new figure is called a regular octahedron. Fluor not infrequently occurs in very fine octahedral crystals, often of considerable size. These three by no means exhaust the crystalline forms in which Fluor occurs, for there are all the varieties that may be derived from a cube or an octahedron by slicing off the angles of the sides, or the edges. For those who wish to pursue this matter further, there is a very interesting set of Fluor crystals in the mineral gallery of the Natural History Museum at South Kensington, showing very clearly the different forms that this mineral may assume.

Fluor crystals are of various colours, and because of some strange property of the mineral, change from one to another according to the angle from which they are viewed. A pale sea-green, pale



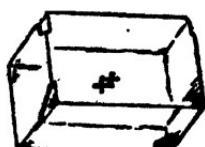
yellowish, blue and mauve, or purple, are the commonest colours, but sometimes crystals of rich emerald green occur. What may be known as Rose Fluor, a fine pink-coloured variety, is found in the Alps, frequently in groups of very beautiful octahedral crystals. Apart from these, some of the finest crystals of Fluor Spar in the world were to be found in England, and of these those from Cornwall rank, possibly, the highest. Here large cubes of bright yellow, or deep and rich purple, surpassing the colour of Amethysts, have been found.

A beautiful violet-blue and yellowish variety, known as "Blue John," is, or used to be, found in Derbyshire, from which the lovely vases so familiar to all are carved. This form is found in veins in the Limestone.

In passing it may be mentioned that from Fluor Spar is obtained Hydrofluoric Acid, which is used for etching glass, and comes nearer than anything else to being the Universal Solvent sought after by the Alchemists of old.

A mineral, said to be rare in Cornwall, which assumes a great variety of beautiful crystalline forms is Calcite, Carbonate of Lime, or Calcium Carbonate (Ca CO_3), to give it its many names. At one time it was called Calc Spar, just as Silica, or Quartz, was called Silex. The system of crystallization is rhombohedral. The purest form of Calcite is the so-called Iceland Spar, which by reason of its clearness, shows very plainly the characteristic

"double refraction" of the mineral. In looking through a piece of this crystal the observer will see two images



D

D.—Crystal of "Iceland Spar," showing the double refraction of an image seen through it.

of any object placed on the opposite side. Calcite crystals are either colourless, or have a yellowish tinge, very rarely mauve, red, or green. It is their many and varied forms that make them so attractive, ranging, as they do, from flat plates, through pyramid-tipped hexagonal prisms, often almost like needles, to the more or less regular rhombohedron. Though said to be rare in Cornwall, there are two specimens in the South Kensington Museum from that county. One is labelled as from Herodsfoot Mine, Liskeard, the other from Tintagel. The latter was presented to the British Museum in 1837 by G. B. Sowerby, the son of the author of "British Mineralogy," and a very keen collector of minerals in his day.

The well-known Tourmaline, whose crystals in their purest and best coloured forms take rank as gems, is found in Cornwall, especially as taking part in the composition of some of the Granites, when the latter are called schorlaceous. As a substance Tourmaline is by no means a simple mineral like the foregoing. It is a compound Silicate of Aluminium, Boron, Iron, Magnesium, with Manganese, Calcium, Sodium, Potassium, and Hydrogen, and has a very complex chemical formula. It occurs in rhombohedral crystals, with long hexagonal prisms, the crystalline formation at one end differing from that of the other. When heated Tourmaline becomes magnetic like Amber when rubber, but the two ends of each crystal are electrically different.

Topaz, which is a Silicate, Fluoride, and Hydroxide of Aluminium, with the chemical formula $\text{Al}_2(\text{F}, \text{OH}_2)\text{SiO}_4$, has been secured at St. Michael's Mount and other places in Cornwall. In a pure form it is of course, a true gem. It occurs in Orthorhombic

crystals of a yellow colour, sometimes greenish, sometimes colourless. It should not be confused with the Occidental Topaz, which is really one of the many varieties of Quartz like the Cairngorm.

Olivine has been mentioned in a preceding chapter as being a mineral of an olive-green colour, which takes part in the composition of many volcanic rocks. It is the chief constituent of Serpentine, which occurs extensively in the Lizard district, and also of the group of rocks known as Peridotites. Some Gabbros also contain a large amount of Olivine. Peridot is the clear, crystalline form, and when pure and of a good colour is valued as a gem.

A very common crystalline mineral, and one which like Quartz enters largely into the composition of such rocks as Granite, is Felspar, several forms being recognised. One of these is Orthoclase, in which the crystals are monosymmetric in form. It is a Silicate of Potassium (or Sodium) and Aluminium, the formula being $K_2O \cdot Al_2O_3 \cdot 6SiO_2$. As the crystals frequently occur in pairs, one at right angles across the other, well embedded in the rock of which they form a part, they often show up in dressed stone, such as the paving stones in the streets of Penzance, as white crosses. Moon-stone is a form of Orthoclase used by jewellers.

Other forms of Felspar are Amazonite, a beautiful, pale green, opaque form much like Chinese Jade, which comes from the Ural Mountains; Labradorite, which displays wonderful peacock-blue, iridescent colours, and takes its name from Labrador, whence, as well as from Norway and Siberia, it comes; and Common Felspar, which is usually of a reddish colour, and gives the rich reddish hue to some Granites.

When Felspar breaks down by the decomposing

action of Hydrofluoric Acid, the result is Kaolinite or Clay, which accounts for the frequent presence of clayey deposits in districts where there is much Granite. In Cornwall there are extensive deposits of China Clay, the working of which forms one of the industries of the county. Indeed, a good deal of this useful substance is exported from Penzance. China Clay is a mixture of Kaolinite and finely divided Quartz, which makes it particularly useful in the manufacture of fine porcelain.

The third crystalline mineral substance that goes to form Granite, as well as entering largely into the composition of many other rocks, such as gneiss and schist, is Mica. This is a substance which is, or should be, well-known to everybody. As Muscovite it occurs in Russia in large masses, and since one of the chief characteristics of the minerals which are called Mica is that they may be split transversely into very thin laminæ, or plates, Muscovite provides us with large sheets of flexible transparent material, which, resisting the action of the heat, and being not easily fractured, may be used for the widows of stoves and the chimneys of gas lights.

As a matter of fact there are a number of different Micas, composed usually of Silica and Oxides of Potassium and Aluminium, with various other element, such as Magnesium and Iron. One variety known as Lepidolite contains small quantities of such substances as Lithium, Rubidium, and Cæsium.

Mica derives its name from its shininess, and in places where it occurs in fairly large pieces scattered through the rocks, it may be seen flashing in the sunlight like small mirrors. Quite large pieces have been found in Cornwall. The mineral is usually of a very dark colour, the blackish spots in Granite

being due to it. Its primary crystalline form is the rhombic prism, but this is not common. Usually it occurs in six sided crystals, more or less flattened.

This brings us to the rocks that go to make up the county of Cornwall, which we may now briefly consider.

ROCKS

The first of the Cornish rocks to be considered is Granite, whose main components, Quartz, Felspar, and Mica, we have studied in the foregoing list of Cornish minerals.

There are four main masses of Granite in Cornwall that occur more or less in a line running down the length of the county ; while the Scilly Isles mark the position of a fifth. The relative ages of these masses are not certain, but it is believed that they are all eruptions from a common source at some great depth, and it is probable that they were intruded into what is known as the " Killas," or the Paleozoic sedimentary rocks of which the greater part of Cornwall is formed, at a time when those rocks were buried, owing to subsidence, at a great depth. These Granites are therefore younger than the Paleozoic Killas, though the latter itself is of considerable antiquity.

The four masses of Granite are known as the Brown Willy mass, occupying Bodmin Moor ; the Hensbarrow mass, lying to the north of St. Austell ; the Carn Menelez mass, lying to the west of Falmouth, north of Helston, and south of Redruth ; and, lastly the Land's End mass, occupying the toe of the Cornish Peninsula. A small mass lies on the coast between Porth Leven and Penzance, while St. Michael's Mount is mainly an isolated outcrop of Granite.

These Granites, known by the respective names of the masses to which they belong, are not all the same in texture, but are closely similar in composition, from which fact their common origin is deduced. Thus they have in addition to the three main ingredients of all Granites—Quartz, Felspar, and Mica—varying amounts of Tourmaline, with occasionally small amounts of Andaluzite, and Topaz. They are coarse in structure, the Land's End Granite being the coarsest, and contain large porphyritic crystals; that is to say, they have large crystals of such a substance as Orthoclase (Felspar) scattered through the general mass, or matrix.

Closely related to the Granites are the Elvan Dykes, in which the crystals of the components are very much smaller than those in the Granites. These dykes are narrow, and occur in great abundance in the Killas that lies adjacent to the Granite masses, as well as in the latter, from which it may be argued that they are younger than the Granites, having been intruded into them and the Killas after they were formed. Probably they originated from the same place as the Granites.

A third kind of igneous intrusion into the Killas is that of the Mica Traps. These, too, are formed mainly of Quartz, Felspar and Mica. They occur mainly from Falmouth running North to Newquay.

Very different from the foregoing are the so-called Greenstones, which occur in dykes round the Granite masses, but represent an older intrusion. They are composed mainly of Hornblende, which gives them their greenish colour, and the constitution of which is Silica, Calcium Carbonate, and Magnesia in combination with Iron and other substances. There is a large mass of this type

of rock occupying the south eastern area of the Lizard, while the outcrops in the immediate vicinity of Penzance and St. Ives are also of Greenstone.

Immediately north of the Greenstone and Serpentine of the Lizard, and occupying the region of Lizard Point the outcrops are of metamorphic rock, mainly Hornblende and Micaceous Schists, which have been produced by the action of the molten masses, that formed the former, upon the sedimentary, though already partly altered, Killas.

Practically the whole of the rest of the exposed rock-surface of Cornwall consists of the Killas of Paleozoic age, containing fossil remains of a very ancient marine fauna.

The county is thus a very good district in which to study the principles of geology, for, it will be seen, we have the ancient sedimentary rocks, such as have been formed by the deposition of fine particles on the bottom of the sea, and into which intrude the igneous rocks, such as the Granites and Greenstones, which by the action of their great heat upon the surrounding sedimentary rocks and upon each other, have given us the various kinds of metamorphic, or altered, rocks. But this is not all, as will be seen by what follows.

To the Killas belong the slates, which are so abundant in, and characteristic of, Cornwall, and the quarrying of which has formed one of the most important Cornish industries for more than three centuries. Slate is too well-known to need much description. It is formed by the metamorphosis by pressure of shales, clays, or muds, and its chief characteristic is the way in which it cleaves or splits, across the direction of the strata of the rock, into the thin, strong, and light sheets, that are so useful for roofing.

In the extreme north-eastern corner of the county, on the border of Devon, the outcrops are of Carboniferous, the greater part of the rest of the county being Devonian, with small areas of Silurian age.

There are no signs of any Secondary, or Mesozoic, deposits, which means that there are no rocks of the Cretaceous (Chalk) period, nor yet of the Jurassic, or of the Triassic periods. The Tertiary, or Cænozoic, deposits are but poorly represented, a few of Pliocene age being known. Quarternary, or Recent, deposits, to which belong the interesting submerged forests dealt with elsewhere, are fairly plentiful, mainly occurring in coastal regions.

It will be seen from what has been written that there is something for the budding mineralogist and geologist to spend his time hunting for ; but it must not be supposed that the minerals and rocks thus briefly dealt with complete the list. Far from it. There are, for instance, all the ores of various metals, in which the county of Cornwall is particularly rich. Amongst these are some very beautiful substances that would grace the collector's cabinet, as, for instance, the lovely blue and green ores of Copper, as well as others of Iron, Nickel, Tin, and so on. One of the best known of the Copper compounds is the beautiful mineral called Malachite. This is a hydrated basic Carbonate of Copper ($2 \text{ Cu CO}_3 \cdot \text{Cu O} \cdot \text{H}_2\text{O}$), and it is of a fine opaque green colour. It is sometimes crystalline, but usually occurs in massive nodular form, cross sections showing pretty markings of alternate light and dark in more or less concentric bands. Usually each mass contains a number of centres round which the bands circle. Often a fine deep blue hydrated Carbonate of Copper, known as Chessylite, is found in association with Malachite,

both minerals being in their crystalline form mono-symmetric.

Chrysocolla is a hydrated Silicate of Copper, and is of a beautiful blue green colour, somewhat paler than Malachite. These three minerals are to be found at Redruth.

But it is impossible to go through all the numerous Hetallic ores that occur in the country, enough having been said here to point the way to a very profitable and interesting field of investigation open to the holiday maker in this part of our island.

CHAPTER X

THE FISHING INDUSTRY, AND SOME SEA FISH

ONE day we decided to pay a visit to Newlyn when the fishermen were bringing in their night's catch. This necessitated an early rise since we had some little way to walk, and fishermen who have been out all night are not likely to dally with their sales in the morning. So, rising betimes, we jumped into knickers and jerseys, and off we set to see what the boats would bring in in the way of fin and scale from the deeps of the English Channel.

As it happened, our brisk walk up Market Jew Street, down through the Morrab Gardens, where the Hydrangeas were a wonder to behold, and along the fore-shore, brought us to Newlyn and the fish market before a single crate of fish had been landed. We had not long to wait, however, for the trawlers were either anchored outside the break-water, or were coming into the harbour.

Blue-eyed men with burly figures, clad in blue-jerseys and high boots, stood round about in little groups, exchanging mild badinage, or else lent over the railings of the sheds, looking to seaward. These were true sons of Cornwall, thick-set, powerful, and not very tall. Other men of a different type, with alert businesslike faces, went from group to group asking questions or merely passing the time

of day. They were the buyers and sellers, and represented that large industrial group—the middleman—such as batten on to most industries in this and other countries, and make a good living by buying cheaply and selling dearly. No doubt *some* middlemen are necessary in the dispersal of commodities in a country like ours; but there seems to be a marked tendency now-a-days in most industries, and especially in such as the fishing industry, for their number to increase beyond all reason, so that a large proportion of them are by way of being little better than parasites. At least, so it seems to a casual observer, when he marks the difference between the price of fish received by the fisherman and the price charged in London or provincial fishmongers' shops.

A third class of people had also assembled at the sheds, not, it must be confessed, out of curiosity, but with a common motive of much greater importance. Small boys, doubtless sent by their mothers, old men and women, too decrepit to work any more, yet with bodies and souls that they still wish to keep together, harrassed housewives with large and growing families—all waited round, ready to trade upon their friendship with, or the good nature of, the kindly fishermen for an odd hake or an undersized conger wherewith to eke out their meagre pittances. Then there were a few spectators, like ourselves, visitors to the place, but unlike us apparently, in that they had no such definite object in view.

In the harbour numerous gulls fought and screamed over bits of decaying fish dragged up from the bottom, or hovered about hungrily awaiting the feast that soon would be theirs, when the sheds should be cleaned up after the sales had been



(Photo by A. de C. Sowerby)

The Harbour at Penzance, with the tide in. Here when the tide goes out ardent pier-head fishermen dig for lug-worms, the best bait for pollacks.



(Photo, by A. de C. Sowerby)

The 'Hilda' lying at anchor: the pier-head, and beyond Mount's Bay, and St Michael's Mount.

accomplished, and the crates and baskets of fish packed off to their various destinations.

Soon the first fishing boat came up to the side of the shed, and at once began unloading its silvery cargo. It was a small trawler, and from its hold huge skates of various species were hauled up by men with serviceable hooks, and flung upon the concrete floor of the shed, where they lay quivering, for many of them were not yet dead. Next some dog-fish, or sharks, were landed in a similar undignified manner, and then a basket or two of flat-fish and some pilchards.

Almost simultaneously a cart, which had come down the quay, pulled up at the back door of the shed and began to discharge its load of fine hakes contained in large baskets. It seems that some of the trawlers had gone out over deep waters and had made an unusually large catch of hakes, which are deep sea fish.

By now more boats were arriving and everybody was soon busily engaged, landing, sorting, and laying out for inspection the fish that were brought in. And a fine assortment it was that morning, though the total catch could not be considered a big one.

The hakes were laid out in rows of a dozen each, sorted so as to make each lot as nearly equal to the others as possible. Some boats that had been fishing with long lines and many hooks, called boulters, landed huge conger eels, and a few cod and bream.

We passed from boat to boat, from one heap of fish to another, eagerly remarking each new form. In one place was a huge pile of scads or horse-mackerels, whose sides displayed the most beautiful iridescent colours. Amongst these, too, and nearly

as beautifully coloured, were a few shads, large herring-like fish.

There were piles of true mackerel and crates of various kinds of flat-fish, such as plaice, dabs, lemon-soles and true soles. Two kinds of gurnard were noted, as well as a few red-mullets, some sea-bream, and half a dozen John Doreys. Besides cods amongst the gadoids, there were large pollacks, coalfish, prouts and whiting, as well as the hakes already mentioned. A single fine specimen of the Common Ling (*Molva vulgaris*, Flem.) recognisable by its grey colour and dark-banded, light-edged fins and tail, was seen lying on the deck of one of the boats. Altogether we counted some twenty-seven different species of fish that were landed that morning.

It is out of the question to go into detailed descriptions here of all these, nor even to give the full list of their names. A few remarks may not be out of place, however, upon some of the more important species, and upon food fish generally.

Undoubtedly the most important fishes of the whole Cornish fishing industry are the pilchard and the mackerel, both of which in their season, the former in the autumn, the latter in the spring, occur in enormous numbers. These, together with the scads, or horse-mackerel, shads, herrings, sprats, and other fish that live and move somewhere near the surface of the sea are called Pelagic, and require different methods of capture from those used in the case of the Demersal fishes, such as keep more to the sea-bottom. To the latter class belong the cods, hakes, pollacks, whitings, congers, all the so-called flat-fishes, such as soles, plaice, turbots, flounders, and brill, besides the skates, dog-fishes, gurnards, breams, and many

others, in fact, by far the greater proportion of marine food-fishes.

The Pilchard (*Clupea pilchardus*, Linn.) is closely related to the Common Herring (*C. harengus*, Linn.) which it resembles both in appearance and habits. It may be distinguished at once by its smaller size, thicker body, larger scales, and the presence of several long, dagger-shaped scales at the base of the tail fin. A close relative of the Mediterranean sardine, from which it differs only in being larger, many authorities considering the two forms as one, the pilchard is exported to the Continent in considerable quantities to be tinned and sold as sardines ; but this source of revenue to the Cornish fishermen is not so large as it was in times gone by, and, though Cornwall is still the main source of supply in these islands of this delectable fish, its presence in enormous quantities off the coasts of the country is no longer as valuable an asset as it was. However, the pilchard fisheries are still of considerable importance. At times phenomenal catches are made, seine nets having been known to enclose in a single hawl many millions of fish. The same may be said of the mackerel, which in spring appears off the Cornish coasts in shoals, or schools, containing countless millions of individuals. There are records of seasons when it was utterly impossible to find either a market or transport for the quantities of fish caught and brought into Newlyn, which place is the headquarters of the Cornish mackerel fisheries.

The Common Mackerel (*Scomber scombrus*, Linn.) is too well known to need description ; but the Horse-mackerel, or Scad (*Caranx trachurus*, Linn.), which is often caught on lines, even from the pier-heads, and is fairly common in the hauls of fishermen in these parts, requires mention. It may at once

be recognised by the series of wide plate-like scales that occur down the middle of each side. It further differs from the true mackerels in that the posterior dorsal and anal fins are long and entire, and not broken up into numerous little finlets. Its body also, is somewhat deeper and less slender than that of the mackerel, and its head larger. Nevertheless, it looks much like a mackerel ; hence its name.

It should not be confused with the Shad, or Allis Shad. (*Clupea alosa*, Linn.), which somewhat resembles it in shape, size, and the brilliant iridescent colouring of the sides ; but belongs to the herring family. The well-known Sprat (*C. sprattus*, Linn.), and the Anchovy (*Engraulis encrasicholus*, Linn.) also belong to the same family, and are taken in Cornish waters. All these species are taken in seines or drift-nets either from some suitable shore or from boats in the open sea.

The Demersal fishes, as might be expected, are mostly taken in trawl-nets, though some are taken, as already indicated, by means of boulders, long lines to which are attached numerous short lines with hooks, and which are laid across some suitable bottom. None of these Demersal fishes, however, form such important items in the Cornish fishing industry as do the mackerels and pilchards, though in the aggregate they are of considerable value.

On the occasion of our visit to Newlyn market by far the most important catch was of Hake (*Merluccius vulgaris*, Cuv.). The generic name of this fish signifies "sea Pike," and indeed it is well so named. Elongate in body, and with powerful jaws, armed with numerous long, sharp teeth, the hake might well be called the Pike of the deeps. It is a deep sea fish, its flesh being soft to the touch.

It belongs to the *Gadidæ*, or cod family, but is characterized by comparatively large scales, and by having the posterior dorsal and anal fins long and entire. In this it differs markedly from the Cod (*Gadus morrhua*, Linn.), the Pout (*G. luscus*, Linn.), and the Whiting (*G. merlangus*, Linn.), in which there are three dorsal and two anal fins.

The flat-fish group, or *Pleuronectoidei*, are well represented in Cornish waters, though they do not form nearly as important a part of the fishing industry here, as they do of those of the North Sea, or even further east on the south coast of England. Some nineteen different species are recorded as Cornish, including such well-known forms as the Turbot (*Rhombus maximus*, Linn.), the Brill (*R. laevis*, Gotts.), the Halibut (*Hippoglossus vulgaris*, Flem.), rare, the Topknots (*Zeugopterus*), the Plaice (*Pleuronectes platessa*, Linn.), the Dab (*P. limanda*, Linn.), the Flounder (*P. flesus*, Linn.), the Sole (*Solea vulgaris*, Quensel), and the Lemon Sole (*S. lascaris*, Risso).

The Skates, Rays, and Dogfish (Sharks) all belong to a very different group of fishes, namely, the Chondropterygians, represented in the list of species recorded from Cornwall by some twenty eight forms. These include amongst their number the peculiar Angel-fish, or Monk-fish (*Rhina squatina*, Linn.), and the Electric Ray, or Torpedo (*Torpedo nobiliana*, Bonap.). All these fishes are characterized by their cartilaginous, or gristly, skeletons instead of bony ones, as in all the foregoing.

Specimens of the Tope (*Galeus vulgaris*, Flem.), the Picked Dogfish (*Acanthias vulgaris*, Risso), the Rough Hound, or Small-spotted Dogfish (*Scyllium catulus*, Linne), and several skates, or

rays were landed the morning of our visit to Newlyn fish-market, and fetched good prices.

A species of fish that deserves special mention is the hideous Angler (*Lophius piscatorius*, Linn.), since the time was when it, as well as dog-fish and skates, were looked upon more or less as offal, and scarcely fit for human consumption, certainly not for the market. Now, however, the huge head and jaws of the angler, which comprise the greater part of the whole fish, are cut off, generally while the boat is still at sea, and only the short, thick, rapidly tapering, but fleshy, body and tail are brought in, finding their way, along with the fleshy parts of skates and dog-fish, to the fried fish shops of London and other large towns.

This is one of the benefits brought about by the war, since fish-food of all kinds was too valuable to throw away, and the value of these coarse kinds was discovered.

Of course several baskets of crabs were landed, which, with a few fine lobsters and spiny lobsters, completed the tale of the night's catch.

By the time all the boats had emptied their cargoes, the floor of one of the large sheds was covered with fish and then began the selling. Various lots had been marked off with names signifying, apparently, the agents to whom the delicate, yet strenuous task of disposing of the fish had been allotted. The purchasers stood round, and, as the price of each lot of fish that they wanted to buy came down to the level they felt they could afford, signified their acceptance of the offer. Occasionally two agents would start on different lots together, at which times their voices rose angrily and they glared at each other till one or other withdrew from the competition.

THE FISHING INDUSTRY, AND SOME SEA.FISH III

The crew of each fishing boat appeared to leave one of their number behind to watch the sales, while the rest, tidying up and putting the long lines in order, pushed off to seek a berth along the breakwater, or quay.

When, at length, the last lot of fish had been sold, men with hooks and knives began skilfully to dissect the skates and dogfish ; with deft strokes cutting away head, offal, spinal bones, and tail. The fleshy parts were crated, as also were the other fish with much ice, in boxes or barrels ; then placed on carts, and driven off to the Railway Station, or to some local destination. The concrete floors of the shed were swilled with water and swabbed down, and the day's work, as far as the fish-market and its hands were concerned, was at an end.

A busy scene, a lively scene, even an amusing scene, yet what an important one. The nightly harvest of the sea being first garnered and then dispersed by swift means to supply the great industrial centres with food.

Would it were entirely so. At the back of one's mind was the thought of the hundreds of thousands of dwellers in the cities to whom fish-food is practically barred, because of its price. They could easily afford to buy at double the price paid to the fisherman, but by the time the army of middlemen have made their profits out of the sea harvest, the price of most kind of fish is beyond them.

One is brought face to face with the ring ; that sinister group of profiteers, the middlemen, who by their machinations keep up the price of fish to the consumer, at the same time beating down the producer, in this case the fisherman, and who, in order to further their nefarious ends, do not hesitate to throw good fish back into the sea rather

than let the poor townsfolk have the benefit of a rich harvest.

The romance of the fisherman's life, and of the great fishing industry is spoiled by this spectre of avarice. How fine would it not be if one could but know, as one looked upon the glittering piles of sea fish, that they were going direct to the consumer, the poor consumer, of our great towns and cities at a reasonable price, instead of mainly to the tables of those who can afford to pay handsomely for them, more as a luxury than a necessity, the profits going further to bulge the pockets of some fat middleman !

Surely, here is a crying need for reform ; something to occupy the attentions of those in authority concerned with the care and organization of an industry to the best possible advantage of the community as a whole. The British Isles are set in the midst of some of the finest fishing grounds in the world, yet the British people have to pay a higher price for their fish-food than the people of any other maritime country. And that price is kept at its high level entirely by the artificial manipulation of the market by those who never risk their lives to obtain a single fish.



(Photo by Gibson & Son, Penzance.)

The Shag (*Phalacrocorax graculus*, Linn).

CHAPTER XI

THE SHAG AND CORMORANT AT HOME

THE Cornish coast is the home of a large number of sea-birds, such as the well-known gulls, the guillemots and auks, and the shearwaters; but there are two species belonging to a very different group that, perhaps more than any of the others, will attract the visitor's attention. These are the Shag (*Phalacrocorax graculus*, Linn.) and the Cormorant (*P. carbo*, Linn.), whose dusky-forms and long slender necks mark them out at once for notice, as they sit upright upon the low reefs and rocks that stand clear of the water well away from the shore.

To those who have not visited these parts before, but only watering places in the east and south of England, these birds will be unfamiliar, for they both keep mainly to the western coasts, being prevalent during the breeding season from Cornwall to the north coast of Scotland, including the Isle of Man.

Of the two forms the shag is undoubtedly the more common in our district, and since the two birds are very much alike in habits as well as in appearance, it may form the chief subject of the present brief discussion of the group to which it belongs.

The family *Phalacrocoracidae* and that of the Gannets, *Sulidae* represent in British waters the Pelecaniformes, in which the members have the

four toes joined together by a web, instead of only three as in the ducks, gulls, and other web-footed birds. They are all purely fish-eaters, and are amongst the most expert fishermen we have.

The shag, except during the nesting season, is not easy of approach, so that its habits, as a rule, can only be closely observed and its movements followed with the aid of a good strong pair of binoculars.

Frequently in the course of our excursions in the extreme west of Cornwall, when scrambling over headlands, or along the rugged rocks at their base, we could see the peculiar, dark, beer-bottle forms of shags and cormorants as they sat in the sun after a bout of fishing. Those that had not long left the water had their wings spread out, apparently to dry. Sometimes some of the birds might be seen swimming about in the water, disappearing often for what seemed minutes at a time, and then reappearing a considerable distance away from the point where they dived down in search of their finny quarry. Sometimes, flying low over the water, with heavy, but rapid wing-beats, birds might be seen approaching from the open sea, or travelling along the shore-line. At such times they looked remarkably like large, black ducks ; but the longer wing, more slender body, longer tail, and, above all, slower wing-beats easily distinguished them.

One of the best places from which to watch these birds is the Land's End. Here one may lie upon the soft and springy sward, high up on the cliff tops, and with glasses adjusted watch them come and go, resting for a while upon the inaccessible rocks below, or catching fish in the crystal clear waters. From such a place, when the sea is smooth, and the birds come near enough in shore, their movements

below the surface of the water may be watched ; and few sights are more interesting than a shag or cormorant in pursuit of fish under water.

But before discussing its habits, let us examine the bird itself. With a length of about thirty-six inches, the shag is characterized by a rather long body, a slender graceful neck, a long slender bill with a wide gape and a sharply hooked nail at the tip, long wings, a rather wedge-shaped tail of stiff feathers, short, thick legs, and large, webbed feet. These are not shaped like those of the duck, nor yet of a gull, but have the outermost toe considerably longer than the others, while the hind toe is connected on its inner surface with the inner toe. Thus the whole foot, by reason of the long outer toe, seems to turn inwards.

In colour the shag may be described as of a uniform black with a strong, green, metallic lustre. The bill is yellowish, or horn coloured, the angle of the gape reddish. The eye is of a bright bluish-green ; the legs are black. The male in the mating season has a strongly recurved tuft of rather long feathers on the top and back of the head. The female is more of a brownish colour, and has no tuft.

The cormorant is a heavier bird, and may at once be distinguished by its white cheeks, naked, yellow face, a crest of feathers, often streaked with white, which passes backwards down the nape, and a white patch on the side of the rump. It, too, has green eyes.

All these features, with the exception, perhaps of the colour of the bill and eyes, may readily be distinguished through the field glasses.

As one watches a sedate old bird sitting in the sun, one may see it preening its glossy feathers.

After a time it waddles slowly to the edge of the rock, then, spreading its great wings, it launches itself clumsily into the air. Alighting on the water's surface, it swims about for a little while, then suddenly it dives, making very little splash. If one is fortunate enough to be in the correct position, the dark form of the bird may be seen, often encased, or partially encased in a film of air, giving it a silvery appearance, darting about, wings shut tight, feet kicking simultaneously, neck held back, crooked. A fish is sighted, and a chase ensues. The bird's speed increases: out goes the long neck: the quarry is seized and born rapidly to the surface, where it is swallowed.

In its under water progress the shag, in common with its relations, differs from the penguin in that the feet and not the wings are used for propulsion. The penguin uses its wings just as a seal or a turtle uses its flappers, its feet being used for steering. From a grebe, the shag differs in that it holds its neck crooked. The grebe's neck is invariably stretched out at full length, the same being the case with the diving ducks.

The fishing finished, our bird either swims back to the rock, or else rises clumsily from the water, and, flying low over its surface, betakes itself to some other favourite haunt. In the breeding season it heads for its nest, where its two or three hungry fledglings await its return. Then may be seen an extraordinary sight. The parent bird opens its mouth, while the youngster dauntlessly thrusts its head down its capacious gape, and eagerly partakes of the partially digested fish stored in the old bird's crop.

The nest, a roughly built pile of seaweed, probably rests upon some cliff-ledge, or upon a rock out of



(Photo by Gibson & Sons Penzance)

The Cormorant's nest and young. Note the materials of the nest, mainly the thick stems of *Laminaria*, or ribbon-weed.

reach of the sea. The shag is said to favour sea caves in which to place its nest. There the eggs from two to five in number, though most probably three, and of a chalky blue colour, were deposited in April, and hatched out by the parent, who, when sitting refuses to be dislodged.

The young when first they appeared were very ugly, being naked and graceless in form, but soon they become covered with soft, black down, when, if not beautiful, they might have been considered very attractive, and quaintly amusing.

The quantity of fish devoured by a single shag or cormorant during the year must be very considerable ; for, it is said, much of that caught and consumed is regurgitated, and, apparently, wasted. This, however, should not be considered a reason for the extermination of these birds on our shores, for, after all there are enough fish in the sea for them and all their kind, as well as for the entire human population of our islands. We, who have not yet evolved an efficient method of distributing the fish that the fishermen catch, have no right to begrudge the sea-fowl their share of the marine harvest. The quantities of fish deliberately thrown away by fish dealers every season, in order to keep up the market price, would feed many large colonies of shags !

Whatever may be said against the cormorant in connection with the destruction of fish in inland waters, the shag may plead "not guilty" on this score ; for it seldom travels inland : it is almost entirely an inhabitant of the sea-shore, and, it is to be hoped, will long remain one of the most interesting ornithological features of such rock-bound coasts as those of Cornwall.

The cormorant, on the other hand, though very much a coastal bird, frequently visits inland waters,

even breeding in suitable places. In such a country as Great Britain, its presence on rivers and lakes of the interior is not suffered gladly, on account of its destruction of our closely preserved fish. On this account it is usually shot when seen, so that it is not a really common bird; but in such places as China and Manchuria, where large rivers full of fine fish occur, and wide, open swamps and lakes are plentiful, it is one of the commonest of the aquatic birds. In the latter country, where the rivers run through heavily forested country, such, for instance, as Central Kirin, enormous cormorant "rookeries" occur, where thousands of birds build their nests and rear their young in the willows along the banks. There would probably be large colonies of cormorants in England and Scotland as well, were the birds allowed to nest on our inland waters, for, of all its family, this species seems to prefer inland to coastal breeding haunts, and one must suppose that it has only returned to the latter in this country under compulsion, as it were.

There it builds its nest much more in the open than does the shag. The usual number of eggs is two, sometimes three, and they are much like those of the shag, being a little larger.

It took a people with the genius of the Chinese to utilize the cormorant in their fishing. Throughout the length and breadth of that country this species—the Chinese bird being in no wise different from ours—is domesticated and trained to catch fish for its owner. Most people are familiar with the little wooden models of a raft and a fisherman with his cormorants, that are offered for sale in such places as Ningpo and Shanghai, and find their way to this country in the baggage of sailors and tourists. They give a faithful representation of how the natives .

of that part of China use the cormorant. In far off Shensi, on the Wei River, your fisherman goes out in two very small boats lashed to each other. He stands with one foot in each boat, and his cormorants sit on the edges awaiting his command to dive into the water in search of fish.

On the shores of the lakes that lie to the southwest of Tientsin, in Chihli province, one may see large numbers of tame cormorants sitting on perches nailed to the willows outside the villages. Here a number of fishermen, often as many as twenty or thirty, join together in their enterprize. They take the cormorants out across the lakes on a single large boat, fitted with perches. A number of small boats, each carrying two men, accompany it. When the fishing grounds are reached, the birds, each with a bit of bast tied round its neck to prevent it swallowing the fish it catches, are ignominiously pushed off their perches into the water. The crew of each small boat immediately takes charge of five or six of them. Then everybody begins shouting and beating tin cans in order to frighten the fish into movement, and the hunt—it is more like hunting than fishing—is on. The birds dive down and come up with struggling fish which they endeavour to swallow. One of the men in the small boats lifts them out of the water by means of a shallow dip net, at the end of a long pole, and pitches them into the boats, where the other man relieves them of their captures and flings them back into the water. After a time the cormorants get sulky, when they are taken back to the large boat and set upon their perches again. When the hunt is over, they are taken back to the village and fed: but though each bird eats copiously of the catch, there are usually

enough fish to supply them, and their masters, as well as the local market.

These cormorants are many of them born in captivity, and so domesticated have some of them become, that they are showing a tendency toward pied plumage. Annual excursions are made to the breeding haunts of the wild birds, however, in order to replenish the stocks, for the cormorant does not, apparently, breed well in captivity.

CHAPTER XII

THE RAZORBILL AND ITS RELATIONS

AMONGST the marine birds that are to be met with round the coast of the British Isles are six species belonging to the *Alciformes*, or auk-like birds. The whole group, which comprises the Razorbill, the Guillemots, or Murres, the Little Auk, and the Puffin, may be described as web-footed birds with short legs, short tails, rather short necks, compact bodies, and small wings. None of them are capable of the sustained flight of the gulls, skuas, or petrels, and their relations. They all spend much of their time at sea, are expert divers and swimmers, and rest upon the cliffs and headlands of rocky coasts and islands. Their greatest variation seems to lie in their bills, the razorbills being of medium length, rather deep, and compressed, that of the guillemots being slender and pointed, that of the little auk short and small, and that of the puffin very deep, not very long, compressed, and, in the breeding season, brilliantly coloured.

Of the six species of auk, as they may be called generically, only three can be considered as common inhabitants of the Cornish Peninsula. These, to give them their popular and scientific names, are the Razorbill (*Alca torda*, Linn.), the Common Guillemot, or Murre (*Uria troille*, Linn.), and the Puffin (*Fratercula arctica*, Linn.).

Of the others, Brunnich's Guillemot (*Uria lomvia*, Linn.), sometimes known as *U. brunnichi* of Sabine,

has been recorded as an accidental straggler, one having been shot, according to Bullmore's "*Cornish Fauna*," about the year 1858 at Rosemullion. This bird is really an arctic species, occasionally reaching British shores in winter. The Black Guillemot (*Cephus grylle*, Linn.) is recorded as a casual visitor to Cornwall, its true range in the British Isles being the north of Ireland, the Isle of Man, parts of the Scottish coasts and islands, and the Orkneys and Shetlands. The Little Auk (*Alle alle*, Linn.) is a winter visitor to Cornwall.

The razorbill, but for the fact that it has retained the power of flight, might well be described as a small edition of that most famous of birds, the recently extinct Great Auk (*Alca impennis*, Linn.). Its bill very closely resembles in shape and proportions that of the latter bird, being deep, compressed, and crossed on the sides with ridges. In the colour and markings of their plumage also the two species are much alike, both being black on the head, throat, neck, back, wings and tail ; white on the chest and lower parts generally. In the great auk an oblong white patch lies in front of the eye ; in the razorbill this is replaced by a white line extending from the upper base of the bill to the eye ; while in both species there is a white bar across the wing, produced by the white tips of the secondary quills. The razorbill, however, has a narrow white band across the bill towards the tip, this feature being absent in the great auk. Otherwise the bills and legs in both species are black.

The great auk is thus described in the present tense because, though extinct for the last eighty years or thereabouts, the species is represented by a number of stuffed specimens in various collections in this and other countries.

It is an interesting and significant fact, that may be mentioned, in passing, that the great auk as the only flightless bird of our northern regions has become extinct. It was killed off in the end by human agency, but it seems probable that it was on its way to extinction before ever it was discovered by man. The North Polar regions, apparently, are less favourable to flightless birds than are those round the South Pole. Otherwise we should have had a number of flightless species, possibly all related to the auk, just as in the Antarctic there are a number of species of penguins, with enormous numbers of individuals. It seems probable that the excessive land-mass round the Arctic has had something to do with this, together with the presence of land carnivores, for whereas the penguins have only been subject to attack by enemies in the water, the great auk met with carnivorous foes on both land and water.

But to return to the razorbill and other present day survivors of the auk family. The razorbill, more, perhaps, than any other member of this group, spends its time out at sea, leaving the coastal regions every year for months at a time. It is usually only during the spring and early summer, that is, during the breeding season, that it comes to land. It then inhabits the cliffs, where the female lays her single egg on a sheltered ledge, and, turn and turn about with her mate, incubates it. This bird is extremely abundant on the Scilly Isles during the breeding season, as well as on other headlands and islands round the Cornish coast. An expert diver, it uses its wings as flippers and its feet only as rudders, when chasing its prey, mainly small fish, under the surface. This fact suggests that it, too, is evolving along the same lines as the great auk did, and is

sacrificing the power of flight for greater dexterity in swimming under the water. This theory is further strengthened when we come to consider the long duration each winter of the razorbill's sojourn on the open sea far away from any land.

On the water our bird swims well ; while its flight, though nothing like that of the gulls, or skuas, is fairly swift and direct, its short wings beating with great rapidity. When at sea, however, it probably keeps entirely to the water, and so is by way of becoming a pelagic species.

When on land it sits erect, with the feet and tarsus of the leg flat upon the rocks ; a position which was also assumed by the great auk. Its walk is a clumsy shuffle.

The egg is very variable in colour, and is less pyriform, or pear-shaped, than is that of the guillemot. The parent bird, apparently, exercises a little more care than the latter bird in selecting a site for the deposition of the egg, choosing spots where crannies or indentations in the surface of the rock offer some sort of hold.

The common guillemot is of about the same size as the razorbill, perhaps an inch or so longer, i.e., about eighteen-and-a-half inches. It is more slender in form. Of a dark-brown on the head, throat, neck, back, wings and tail, it is white on the chest and underparts, with a white bar on the wing. Thus, at a distance, it might be mistaken for the razorbill, the only distinguishing feature being its slender bill.

The guillemot is said to be numerous round the Cornish coasts, nesting in the same places as the razorbill. It is certainly not as numerous as the latter species, however.

This species also takes to the open sea in winter, only being found near land when driven in by storms.



(Photo by Gibson & Sons, Penzance.)

The Razorbill (*Alca torda*, Linn.)

The Cornish fisher-folk know it by the name "murre," said to be derived from the peculiar growl it makes when angry. In common with most of its kind, the common guillemot lays one egg. It is extremely careless as to where the latter is deposited; any ledge seeming to do. The result is that the eggs frequently roll off and are smashed. How a bird that lays but one egg a season, and is so careless with it, has managed to survive in such large numbers is a puzzle, especially when we take into consideration the care bestowed upon their eggs by so many other species that lay several, and yet seem to find it all they can do to keep up their numbers.

While out in Mount's Bay during the month of August the writer saw several specimens of both the razorbill and the common guillemot, engaged in diving and fishing. This was probably somewhat late in the season for either bird, but there was no mistaking them as they came quite close to the boat.

Once, when passing in a steamer down the English Channel in June, I observed numerous small birds appearing and disappearing on the smooth surface of the sea. With the aid of glasses these were seen to be puffins, their brightly coloured bills being plainly discernable. Sometimes one would come to the surface within a few yards of the steamer, apparently, in no wise disturbed by the propinquity of the vessel. This must have been well down the Channel fully fifty miles from land. As it was during the nesting season, it suggests that these birds are capable of a comparatively long flight.

Though no puffins were seen during our stay in Cornwall, the species is well known in the general region; breeding, as it does in large numbers on the Scilly Isles, and at Tintagel and Trevalga. A

certain number breed on the south coast, while the species has been recorded as passing the Lizard in great numbers in autumn flying westward.

The puffin may be described, briefly, as a small compact, rather stout bird, with dark black-brown upper parts, wings, and tail; white cheeks, chest, and lower parts; its short, deep, compressed bill coloured blue at the base, red at the tip, with yellow and red bars across the middle; its eye yellow, with orange-red lids and a bluish fleshy plate above it, a similar bar below; its legs and feet of an orange-red.

It chooses for its nesting site the grassy tops, or the slopes of headlands, or turf-covered islands, where it either excavates burrows for itself, or else adapts those of the rabbit to its use. Sometimes a rough nest is made in the burrow; frequently the single egg, which is of a dull white colour with faint reddish or greyish spots, is laid on the bare earth.

Both the puffin and the guillemot use their wings to propel them when swimming under water, and their webbed feet only to steer by, or as paddles when on the surface. Their food is small fish, which they swallow under water unless they are intended for their young. When thus laden and on the ways to their young, these birds are attacked by the gulls, especially the great black-backed gull and the herring gull. Indeed, the smaller bird, the puffin, is not infrequently attacked for its own sake, and when killed, its body torn open and its entrails devoured by the hungry gulls.

CHAPTER XIII

AN AFTERNOON WITH THE SEA BREAM

IT was one of those warm days with scarcely a breath of air to ruffle the surface of the green oily-looking water in the harbour. The sky, partially obscured by what might be called a heat-haze, was of a pale washed-out sort of blue, while the white ball of the sun, though failing to dazzle the eye, nevertheless, beat upon one's back with unusual heat.

We had arranged overnight with a local fisherman to take us bream fishing in his trim little boat, the *Hilda*; and, as we came to the quay side, where the stone steps ran down to the water, he was heard to mutter : " It looks as if it was going to be a rowing match out there."

Nothing daunted, however, by the prospect of a strenuous pull, if good sport might be found at its end, we descended into the boat and put off. Out to seaward we went, past the pier-head, where could be seen our fellow anglers of the day before, with their puny rods feebly fishing for the fickle pollack. As we passed, a small boy landed a fine fish, its bronzey sides flashing in the sun as he whirled it through the air.

But we were bent on nobler sport than pollack-fishing from the pier, and could afford to smile at the excitement the landing of the fish caused. Let them have their pollacks, dozens of them if they

liked ! We were for the beautiful silvery-pink, long-finned, big-eyed Sea Bream, *Pagellus centro-dontus*, De la Roche, to give him his classical appellation, and what were mere pollack to us ?

Heading in a southerly direction, we rowed steadily for a while. It was warm work, and not too much to our liking. But, presently, a large motor-driven fishing boat came racing up behind us, and our guide hailed its skipper, asking for a tow. Promptly the fishing boat swung into position just ahead of us ; a rope was thrown, and, in less time than it takes to tell, we were speeding along for the spot, where, said our captain, he had taken bream every day for a week.

As we neared the magic spot, our guide began taking his bearings : " The bell-buoy in line with the white house beneath the quarry beyond Newlyn, and the Penzance lighthouse under the small, rather pointed hill. So. Them's the marks. Steady : let go ! Many thanks ! " and with a wave to the skipper and crew of the motor-trawl, who wished us good luck, we dropped behind. A few strokes of the oars brought us to the exact spot : over went the anchor, and the *Hilda*, caught in the drift of a shoreward current, came to rest over the favourite feeding grounds of a shoal, or shoals, of sea-bream.

Half a dozen mackerel lay in the bottom of the boat, and one of these, selected for its " ripeness," was now cut into pieces, in inch or so square ; the hooks, two on each of the three lines, were baited with the tempting morsels ; and, as each line was ready, it was heaved overboard in the approved style, and was given to one of us.

We were each given various instructions as to how to hold the line ; how to tell when we had a

bite ; and what to do when we felt a fish at the other end of our line. It was all very exciting, for somehow we felt we were on the eve of great events. Our guide's cocksureness communicated itself to us. Sonny's little hands were trembling as they held the line taut. His mother sat on the opposite side of the boat, her face all eagerness. I tried to show a calm exterior, but it was no use. In spite of many years' experience in the arts of hunting and fishing, I was in the grip of the thing. Hunting and fishing are always hunting and fishing, no matter what the quarry, and the tenseness of the moment had got me. . . .

But things did not begin to happen all at once. There was time to look round. Sonny, looking over the side of the boat, discovered several small Garfish, and almost fell overboard in his attempt to grab one. Not far from the boat a couple of Guillemots, or Murres, as the fisherman called them, were floating on the oily surface, or diving for fish. A Razorbill flew past and settled some little distance to seaward. . . .

And so we waited, while our skipper prepared a drift line with a single hook, which he let out from the bows of the boat.

"They'll be round in a minute," said he, "it generally takes a little while for them to get the scent."

What was that ? I felt a gentle but distinct tug at my line. Jerking my hand up, I felt a sudden strain that had not been there before. Swiftly, hand over hand, I pulled in the line. Soon, in the clear greeny-blue water below me, I could see a large, silvery form darting from side to side. My shout of triumph set every one agog. For the second time Sonny all but took a header into the

water as he leaned over the side to see my prize coming reluctantly to the surface. Up it came, clear of the water, a large, quivering mass of silver and pink. Just as it reached the gunnel of the boat something happened, and with a splash the fish fell back into the sea.

"Gone! what a shame; and such a beauty!"
"That was a big fish, Sir."

"Oh, Daddy!"

Accusing voices and looks from my companions: and inside that hateful little voice: "Why didn't you swing it clear of the side. If only you had . . ."

"Never mind, Sir, there are plenty more; but you won't see a bigger one than that to-day." This from the fisherman, and, as it turned out, he was right.

Scarcely had my line, with the hooks re-baited, plumbed the depths below us, than I felt another gentle tug. Again it came, and once more the line came racing in as I drew in its dripping coils. This time, as the fish left the water, I gave a swing outward, upward, and over, and there in the bottom of the boat lay the most beautiful, quivering form it is possible to imagine. It is no use judging of the sea-bream's beauty from the poor, dull, discoloured creatures one sees on the fishmonger's marble slab: to appreciate it one must see the fish all alive, just as it leaves the water. The fishmonger's ware is to the newly caught bream, as dulled and tarnished silver is to the new and highly polished article in the jeweller's shop.

In the newly caught fish there is not a mark on the silvery, burnished sides; a delicate golden-pink pervades the glistening scales; the long fins and deeply forked tail are of a fine salmon-pink; the great eyes are black as ink and rimmed with gold;

the whole the very perfection of Nature's choicest handiwork, her supremest effort in the creation of a beautiful living thing.

What a crime to kill it ! For a moment the impulse to replace it in the sea was almost overpowering—and then : “ I’ve got one ! ” A joyful cry from my wife and, like a surging sea wave, the old primeval instinct swept back into its accustomed place, and once more I was man the hunter and fisher : no longer man the dreamer, the artist, and, for the time being, only a very little the lover of Nature. Nature had reasserted herself in another way. . . .

Into the sea went my line, only to come flying back laden with another bream.

Meanwhile the lady had successfully landed her fish, and was calling for help to get it off the hook. I landed my catch, and then unhooked both fish. While the fisherman was rebaiting the hooks, I turned to Sonny to see why he had not yet got a bite. He was whimpering at his bad luck ; but the moment I touched his line I knew that he had a fish on the other end of it. There was no mistaking the sharp tugs. It did not take long to bring it in ; behold, it was a monster, that is to say, a monster compared with those already caught, but still not as large as the first one that had got away.

For some little time after that we gave the fisherman no rest, for as fast as he could bait our hooks, and we could get them overboard, the fish took the bait ; sometimes to get hooked, sometimes escaping with the succulent mouthful.

Great excitement reigned when I got a “ double,” that is, a bream on each of the two hooks of my line. Our respective bags began to mount up, and now we had about five fish each.

Then came a lull, during which the skipper had time to pull in his own line, that all this while had remained unattended. It was found to have a good sized bream on the end of it.

Another rush of fish came, and again excitement ran high ; but now, whether from lack of skill on our part, or because the fish had grown more cunning with experience, many more escapes than captures were recorded. As a matter of fact the mackerels brought for bait were all used up, and we had had to cut up and use one of the breams, whose flesh being soft probably came off the hooks more easily. Probably, too, the bream did not care for it so much as they did the high-flavoured mackerel, and so, instead of seizing it greedily, nibbled it away. Whatever the cause, we progressed more slowly, though we steadily added to our catches.

A particularly vicious tug at my line, and considerable resistance as I drew it in, made me think I had caught the king of all the breams ; but it turned out to be only a large pollack, which, unfortunately, made its escape, ere I could get it over the gunnel.

Our skipper, who was now able to give more attention to his own line, also caught a couple of pollacks, a good deal larger than those we had caught from the pier. Besides these, nothing but breams were caught, and when, at last, all biting ceased, as it did at about five o'clock, and we decided to call it a day, there were thirty of the bonniest fish it has been my lot to see lying in the bottom of the boat. I have seen many much larger catches in different parts of the world, with bigger and, perhaps, better fish, but those twenty odd bream, all much of a size, excepting two, which were half as much again as the others, with their exquisite silvery,

pink, and golden colours, were wonderful to behold.

Of the total catch nine bream belonged to Sonny, who also had caught the largest, seven each belonged to his mother and me, and five bream and the two pollacks to the fisherman.

Not a very large catch, perhaps ; but who reckons his bag in mere numbers ? We had enjoyed to the full every minute of a long summer afternoon, and, after all, that is what counts.

As a fresh breeze had sprung up while we were fishing, it was decided to go for a sail in Mount's Bay, with the mackerel line and spinner over the stern, to see if we could not round off our catch with a few of these sporting fish. But it was not to be, after about an hour's spin, we headed for the harbour, and supper. Meanwhile, I tried to pump the fisherman in regard to the bream and what he knew about them and their ways. He did not seem to know much, however. He thought they went about in shoals, keeping near to the bottom. There were days, he said, when you could not get a bite anyhow, and others when you could not bait the hooks fast enough. They were generally to be found in certain rather limited areas, and so on : information that might be useful enough to a prospective fisherman, but nothing much of the fish themselves.

As a matter of fact the Common Sea-bream, as we must call our species, belongs to that great group the Demersal fishes, which keep entirely to the bottom, and which cannot come near to the surface for long without having their internal economies all upset by the difference in the pressure of the water. Belonging to the order *Acanthopterygii*, the fishes with spiny, or stiff-rayed fins, the sea-breams, of which there are several species in these waters, are related to the sea-basses and scienid fishes.

They all have rather deep compressed bodies, high dorsal fins, long pectorals, and long, widely-forked tail fins, large eyes, sharply descending foreheads, and rather large scales, which extend on to the gill-plates and cheeks. They are all beautifully coloured, even the Black Sea Bream (*Canthus lineatus*, Mont.), which occasionally occurs in Cornish waters, and is the dullest of the lot, being not inelegant.

Altogether some ten members of the family *Sparidae*, to which the sea-breams belong, have been recorded from Cornish waters, though the only ones at all common beside our species are the Spanish Bream (*Pagellus erythrinus*, Linn.), a fine red-coloured species, and a form called *P. bogaraveo*, Brunn, which is also known by the same popular name.

The Gilt-head (*Pagrus auratus*, Linn.), Couch's Sea-bream (*P. orphus*, Risso), the Axillary Bream (*Pagellus owenii*, Günth.) and its near relative *P. acarne*, C. & V., the Bogue (*Box vulgaris*, C. & V.), and the Four-toothed Gilt-head (*Dentex vulgaris*, C. & V.) must be considered of but rare occurrence, being either Mediterranean or Atlantic species that appear only as stragglers.

Judging from their teeth the sea-breams, as a group, are voracious feeders. The Four-toothed Gilt-head is particularly well armed with long, sharp teeth, and is a very savage and predaceous species. In the Gilt-head and the Spanish Bream, the posterior teeth are large and rounded, eminently suited to crushing the shells of molluscs and crustaceans, on which these fish live.

The sea-breams are mostly inhabitants of deep waters on rocky coast-lines, apparently liking a rocky bottom.

CHAPTER XIV

SEA-SHORE CRUSTACEANS

AMONGST the most characteristic of the inhabitants of the sea-shore are the crustaceans, crabs, lobsters, shrimps and the like, which may be said to take the place in the sea of the insects, spiders, ticks, scorpions and centipedes on land. They belong to a common phylum, or branch of animal life, known as the *Arthropoda*, or animals with jointed limbs. The crustaceans as a whole represent an early marine stage in the development of the Arthropods, for it is clear, both from an examination of their structure and on the evidence of their fossil remains, that the members of this great branch originated at a very remote period of the world's history in the sea, and that from time to time various off-shoots left the maternal element and took to the land.

We have elsewhere noticed that the land molluscs originated in the sea, some comparatively recently ; while some are at the present time in the very act of making the change from one element to the other. The same took place with the land vertebrates, though in this case two at least of the great classes, the mammals and the birds, arose from early reptilian forms, after the latter had been long established on land. In the vegetable kingdom the same transition from sea to land may be noted. The *Algæ*, which are dealt with elsewhere in these pages, represent the earliest form of plant life, and, though

many forms still exist in a primitive state, the group undoubtedly gave rise to all the cryptogamic land plants, such as mosses, horsetails, and ferns, and through them to the flowering plants.

So with the Arthropods : the earliest forms are to be found in the earliest fossiliferous rocks of Cambrian age as Trilobites, which were marine. In Cambrian times these had already given rise to two other branches of marine Arthropods, the Eurypterids, or sea-scorpions, which in turn gave rise to the land-scorpions, spiders, ticks, and other terrestrial members of the class *Arachnida*, and to the present day marine Arachnids, the King-crabs (*Xiphosura*, or *Limulus*) ; and the earliest crustaceans, such as the mid-Cambrian shrimp-like *Burgessia bella*, which, as has been pointed out by Professor Osborn, closely resembles the present day *Apus lucasanus*, a representative of the primitive crustaceans that belong to the order *Branchipoda*, and of which *A. cancriformis* is the European form, to be found sometimes in ponds and ditches.

The crustaceans as a whole have remained marine, or at least aquatic, in their life-environment, but we have in the *Isopoda* certain forms which represent a transitional stage from sea to land, as well as others that have become entirely terrestrial. Of these the Sea Slater (*Ligia oceanica*, Linn.) may be cited as representing the transitional stage, the Common Wood-louse (*Oniscus asellus*, Linn.) as a form that is purely terrestrial, and *Idotea balthica*, Pall., as still entirely marine.

The study, then, of the crustaceans is very important, if we are to understand the phylum *Arthropoda*, which, it may be mentioned, contains by far the greater part of the animal forms known to occur on the earth to-day. Indeed, one of its classes, *Insecta*,

or the true insects, contains something like a quarter of a million known distinct species, which number exceeds that of any other single group of animals.

The number of crustaceans that inhabit the area between tide-marks of any coast-line is very considerable, and that of Cornwall is no exception. In the course of our holiday investigation we secured or encountered over a score of different species belonging to widely different families, but still representing only a tithe of the species that might have been taken had we devoted our whole time to them.

Though it is not intended here to go deeply into the systematic classification of the *Crustacea*, a few remarks upon the subject may prove helpful, since the class is not an easy one to understand without some idea of the natural arrangement of the orders, families, and other groups into which it falls.

The *Crustacea*, then, are divided into two subclasses, *Entomostraca*, and *Malacostraca*. Of these the former contains a number of small, simple or primitive forms, such as the *Apus*, already referred to, and the Water-flea (*Daphnia pulex*, de Geer), of the order *Branchiopoda*, which, being mainly fresh-water in their habitats, do not here concern us, though numerous species have been recorded from Cornwall. It also contains the orders *Ostracoda*, *Copepoda*, and *Cirripedia*. Of these the first contains a number of minute fresh-water and marine forms characterized by having the carapace in the form of two shells, much resembling those of a bivalve mollusc, which enclose the whole body and legs. Some forms, notably the *Halocypridae*, are planktonic in their occurrence, but mostly they are benthic, or inhabitants of the sea-bottom. The Copepods are also minute, rather primitive crustaceans, that occur mainly in the Plankton, though they are to be found

also in the Benthos of the foreshore. The *Cirripedia*, or barnacles, will be dealt with later, but it may be stated that they represent degenerate rather than primitive forms.

The *Malacostraca* contain the larger crustaceans, such as are easily examined with the naked eye. These are characterized by the possession usually of twenty segments, or somites, with a pair of limb-like appendages attached to each. Though there are three orders we are concerned here only with two, since *Leptostraca* contains very few representatives, which, it may be remarked, are small and have the carapace bi-valved, the head, legs, and "tail" being clear of the valves. *Nebalia bipes* is recorded from British coastal waters, but is of almost world-wide distribution.

The other two orders are *Thoracostraca*, containing all the species which have stalked eyes, and in which the anterior segments are fused together to form a thorax with a carapace; and *Arthrostraca*, which have non-stalked, or sessile, eyes, and no carapace, the whole body being segmented.

The *Thoracostraca* includes the sub-orders *Schizopoda*, which have eight pairs of forked appendages on the thorax; and the *Decapoda*, in which the last five pairs of thoracic appendages are not forked and are used for walking, and so are true legs, hence the name which signifies the presence of ten legs. With the *Schizopoda* we are not much concerned, since we did not come across any of its members. The sub-order has been given up by some authorities, who place one of its divisions, the *Euphausiacea*, containing such prawn-like forms as the deep water *Meganyctiphantes norvegica* of British and Continental coasts, with the *Decopoda*; and another, the *Mysidacea*, of which the commonest British form is

Macromysis flexuosus, Müll., in another group called *Peracarida*.

The *Decapoda*, containing, as it does, all the well known forms, such as the lobsters, the hermit crabs, and the true crabs and prawns, concerns us here more, perhaps, than any other group of crustaceans. It falls into three divisions, namely :

Macrura, in which the abdomen is long, such as in the lobster and prawns.

Anomura, in which the abdomen is less developed, as in the plated-lobster and hermit crab.

Brachyura, in which it is much reduced and tucked up under the thorax, as in the common horse-crab.

There are two other sub-orders belonging to the *Thoracostraca*, namely, the *Stomatopoda*, containing the peculiar forms of the genus *Squilla*, or sea-mantis, and the *Cumacea*, of which the common British species is *Iphinoe trispinosa*, and which is included by some authorities in the *Peracarida*, already referred to.

The order *Arthrostraca* is divided into two further sub-orders, the *Amphipoda*, containing the well known sand-hoppers and their kin, and the *Isopoda*, containing the sea slaters, the gribble, and the land-inhabiting wood-lice and pill-bugs.

In order to make this classification clear the accompanying table has been prepared, from which at a glance may be seen the exact position of any of the families whose members are mentioned in these pages. It may be mentioned, however, that by some authorities the sub-orders in our table are given as orders, and our orders as divisions, or series ; but the present system is quite adequate to our needs here.

CLASSIFICATION

CLASS	SUB-CLASS	ORDER
		Branchiopoda
		Ostracoda
		Copepoda
	Entomostraca	Cirripedia
		Leptostraca
Crustacea		Thoracostraca
	Malacostraca	
		Arthrostraca

OF CRUSTACEA.

SUB-ORDER	DIVISION	FAMILY
Phyllopoda		
Cladocera		Daphniidæ
Thoracica	Pedunculata	Lepadidæ
	Operculata	Balaniidæ
Rhizocephala		
Schizopoda		
Decapoda	Brachyura	Cancriidæ Xanthidæ Portunidæ Maiidæ
	Anomura	Galatheidæ Porcellanidæ Paguridæ
	Macrura	Nephropsidæ Crangonidæ Pandalidæ Palæmonidæ Palinuridæ Scyllaridæ
Stomatopoda		Squillidæ
Cumacea		
Amphipoda		Talitridæ Gamaridæ
Isopoda		Limnoriidæ Ligiidæ Oniscidæ Armadillidiidæ Idoteidæ

We may now consider the various species of Cornish crustaceans that came under our notice in the vicinity of Penzance. For this purpose it is proposed to reverse somewhat the order given in the table, and to deal first with the *Decapoda*, since they form the most conspicuous group, then with the *Amphipoda* and *Isopoda*, and last of all with the *Cirripedia*, or barnacles.

Of all the true crabs (*Brachyura*), the most important to us, economically, is the Edible Crab (*Cancer pagurus*, Linn.) of the family *Cancridæ*. It is too well known to need description. Common amongst the rocks towards low water-mark, it nevertheless attains its full size only in deep water. It may be found hiding in the crevices at the base of rocks or under stones in rock-pools. It reaches a great size, some very large specimens being taken off the Cornish coasts.

The equally well known Common Shore Crab (*Carcinus mænas*, Linn.), which belongs to the same family, is easily distinguishable on account of its smaller size, longer legs, more slender claws, or Chelæ—as the two great pincer-like limbs of the thorax are called—and its green or orange-brown colour. It frequents much the same places as the younger edible crabs, but extends higher up the shore. It is rather an interesting fact, which may be noted here, that the rocky, weed-covered parts of the foreshore appear to be the nursery of a number of marine animals, which, in the adult state, keep more out to sea or in deep water. Of fish the pollack, and the three-bearded rockling may be cited as examples, though there are others. Many crustaceans show the same habit, and of these the edible crab, the common hermit crab and the plated-lobster may be mentioned, as well as the common.

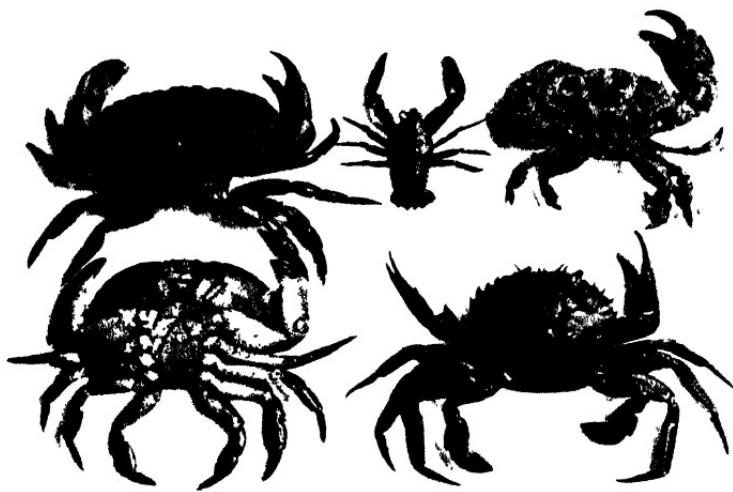
prawn. Other forms, such as the shore crab, seem to keep exclusively to the rocks between tide-marks.

About the same size as the shore crab, and somewhat resembling it in general shape, is the Velvet Swimming Crab (*Portunus puber*, Linn.). The swimming crabs may at once be distinguished by the fact that their hindermost pairs of legs are flattened at their tips into paddles, which enable the crabs to swim rapidly; hence the name. Our species is covered with brown hair, with naked blue patches and streaks on the carapace and legs, and with the inner sides of the joints bright orange, very conspicuous when the crab holds its chelæ wide apart, as it does when preparing for attack. The outer anterior edges of the carapace are strongly serrate, more sharply so than in the shore crab, the antennæ are rather long. This species has been placed in a distinct family *Portunidæ*. Another species, *P. depurator*, Linn., is also common.

Another crab that frequents the rocks and attains a size but little short of that of the shore crab is the so-called Furrowed Crab (*Xantho incisus*, Leach) of the family Xanthidæ. In this species the chelæ are proportionately very large and powerful, the legs are rather short, and the carapace deeply furrowed on the back, and coarsely and bluntly serrate on the margin. The antennæ are very short. It is of a dull purplish-brown colour, the tips of the claws being black. The Lesser Furrowed Crab (*X. hydrophilus*, Herbst.) is a smaller form that has been recorded from the Cornish coasts, as also has Couch's Furrowed Crab (*Xanthodes couchii*, Couch). Another small species belonging to the same family is the Furry Pilumnus (*Pilumnus hirtellus*, Linn.) which is very numerous under stones low down on the rocks. It may be recognized by its small size and hairiness.

The Spider crabs differ from the foregoing types of crab in the shape of the carapace. This is more elongate from back to front, less wide and flattened, than in the species we have just considered. The chelæ, also, are more slender, often longer, and generally weaker. The best known example on the British coast is the Spiny Spider Crab (*Maia squinado* Herbst.) of the family *Maiidae*. This species reaches a large size, comparable with that attained by the edible crab, but it is a very different looking creature. Its body is roughly pear-shaped, its margins of the carapace being armed with large spines, of which the two anterior ones, situated over the mouth and between the eyes, are the largest. The chelæ are comparatively small and weak. Most of the spider crabs go in for camouflage on an elaborate scale, usually by bedecking themselves with bits of seaweed and sponge, which they place in position themselves, and which are held there by the hairs of the body and limbs, the larger specimens, which live in deep water, do not mask themselves to nearly the same extent as the smaller ones. The latter may sometimes be found amongst the floating weeds near low-water mark, when they may easily escape detection, resembling, as they do, mere masses of broken up weeds. In large specimens the shell is often encrusted with barnacles and various marine accretions, so that the animals might well be mistaken for pieces of rock or loose stones. They are often caught in lobster pots, and are used as food by the natives of the Cornish coast, there being no market value for them.

Specimens of a related Mediterranean form, *Dormia vulgaris*, M.-Edw., have been dredged in Cornish waters, and found to be covered with a mass of sponge of the species *Cliona celata*, with which they



(Photo by A de C. Sowerby.)

Crabs of the rock-pools and fore-shore. *Left*: Two Edible Crabs (*Cancer pagurus*, Linn.), back and undersurface. *Right*: The Furrowed Crab (*Xantho incisus*, Leach.), below the Swimming Crab (*Portunus depurator*, Linn.). *Middle*: The Plaited Lobster (*Galathea strigosa*, Linn.), with abdomen extended.



• (Photo by A de C. Sowerby.)

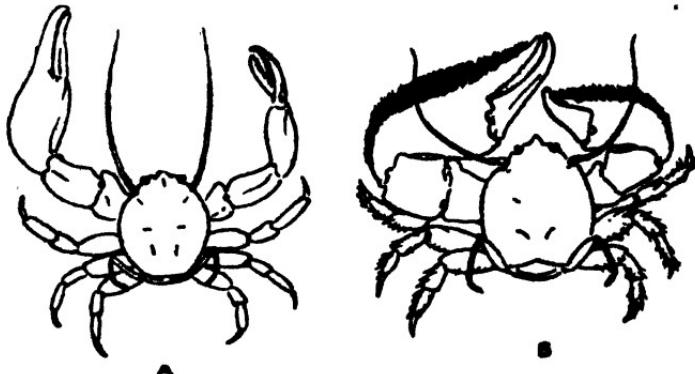
The Spiny Spider Crab (*Maia squinado*, Herbst.)

apparently live in a state of symbiosis, or mutual interdependence, the sponge camouflaging the crab, in return for its services being carried about by the latter, and so able to fare more richly.

The Masked Crab (*Corystes cassivelalaunus*, Penn.) is another rather long-bodied species, which derives its popular name, not from any habit of masking itself like the spider crabs, but from the fact that its carapace is grooved in such a way as to show some resemblance to the human face. In this species the male has the chelæ enormously and almost equally developed, these being very long rather than massive, while in the female they are short and comparatively weak. The members of this species are not commonly seen because of their habit of burying themselves in the sand about low-water mark. Though we did not secure specimens, the species is recorded from Penzance and other places as being fairly common.

Down amongst the rocks, not far from sea-water mark, under the large, loose boulders, several peculiar members of the division *Anomura* are to be found. As this term suggests, there is no very definite condition of the abdomen, or "tail" in the species that belong to this division. That is to say, it may be fairly long, as in the hermit crabs, very short as in the porcelain crabs, or of medium length as in the plated-lobster. The real distinguishing feature of the members of this division is that they all have only six well developed walking legs, what corresponds to the last pair of walking legs in the true crabs being either very small or absent. Two of the forms to be found amongst the rocks are very crab-like in appearance. These are the little porcelain crabs, of which one, the Flat-clawed Porcelain

Crab (*Portellana platycheles*, Penn.) may be recognized by its enormous flat chelæ, and hairy covering, the other, the Common Porcelain Crab (*P. longicornis*, Linn.) being practically hairless, shiny, and



A.—Common Porcelain Crab (*Porcellana longicornis*, Linn.).

B.—Flat-Clawed Porcelain Crab (*P. platycheles*, Pennant).

somewhat smaller. It may be noticed in both species that the posterior walking legs are very much smaller than the others, and are turned up over the back. In both forms the antennæ are very long and slender. These species belong to the family *Porcellanidæ*, and closely related to them, but very different in appearance, are the members of the family *Galatheidae*, one species of which is to be found side by side with them under the rocks and stones close to low-water mark. This is the so-called Plated Lobster (*Galathea strigosa*, Linn.), a creature that looks like a squat somewhat flattened lobster or crayfish with rather long chelæ. These two forms, the porcelain crabs and the plated lobsters—for there are more than one species of the latter—afford a good illustration of the anomalous shapes of the various members of the *Anomura*. In the plated lobster the carapace is somewhat elongate, tapering anteriorly into a spinous rostrum. It is traversed by grooves, which gives it a scaly or plated appearance. The abdomen

is more developed than in any of the species we have yet examined, and when straightened out is not unlike that of a crayfish. The long chelæ are also much like those of a crayfish, and are armed with sharp spines. The antennæ are very long. It is only when the legs are examined that the relationship of the *Galatheidæ* with the *Porcellanidæ*, and *Paguridæ*, or hermit crabs, becomes evident. The last pair of thoracic legs are small and turned up over the back as in the porcelain crabs. If a hermit crab be removed from its shell and examined, it will be found that the last two pairs of thoracic limbs are thus small and upturned. It may be remarked, by the way, that crustaceans are classed mainly according to their appendages, or limbs, so that when we come across a common feature, such as has just been discussed, in several very different looking forms, we know that they are probably related, and when more than one feature of this nature occurs we are safe in classing together the forms that possess them. Care must be taken to determine that the characters are homologous and not merely analogous. But to return to our plated lobsters. The largest specimen obtained by us measured about three inches with the abdomen stretched out. *Galathea squamifera*, Leach, and the related and much larger *Munida rugosa*, Fabr., have also been recorded from the same situations in Cornwall, though the adult of the latter, at least, lives in deep water. In it the chelæ are very much longer and more slender than in our species, which it otherwise resembles very closely.

The well known hermit crabs hardly need description. Occupying the empty shells of gastropod molluscs in order to protect their long, rather swollen and soft abdominal parts, these crustaceans

swarm in all the rock-pools, as well as on sandy bottoms. The commonest are the members of the genus *Eupagurus*, of which three species occur in Cornish waters. These are the Common Hermit Crab (*E. bernhardus*, Linn.), Prideaux's Hermit Crab (*E. prideauxi*, Leach), and *E. cuanensis*, W. Thomp.

The common species is the one usually found. It reaches a large size, when fully grown fitting comfortably into the shell of the Common Whelk (*Buccinum undatum*, Linn.). *E. prideauxi* is said to be found constantly in association with the Sea Anemone, *Adamsia palliata*, another case of symbiosis, in which the anemone serves to mask the crab as it clings to the outside of the mollusc shell, while the crab carries it about and lets it feed, so to speak, on the crumbs from its table. Apparently the hermit crab, with all the acumen in this direction possessed by its kind, places the anemone on the shell in the first place, and, it is said, when a removal to a larger shell is necessary, transplants the camouflaging polyp. *E. cuanensis* may be distinguished by the very hairy nature of the upper surface of the large right chela. It associates with a sponge called *Suberites ficus*, the latter, having settled on the shell, completely enveloping it in time and dissolving away its substance, so that the crab comes to occupy a spiral cavity in the sponge in place of the shell. This is obviously a better home than a shell, for the sponge grows with the crab, and obviates the necessity of a change of dwelling.

Several other genera of hermit crabs are known from these coasts, one of which possesses the appropriate name of *Diogenes*.

The last division of the *Decapoda* contains the lobster, the spiny lobster,* the shrimps and prawns,

and several other interesting crustaceans, in all of which the abdomen is long and usually carried in an extended position. The Common Lobster (*Homarus gammarus*, Linn.) of the family *Nephropsidae* may be taken as the typical form. This species, known to everybody and therefore requiring no description, is extremely abundant along the Cornish coasts. Its capture and sale form a very important part of the Cornish fishing industry. Almost as well known, but not quite so plentiful is the Common Spiny Lobster (*Palinurus vulgaris*, Latreille), which belongs to the family *Palinuridae*. It may at once be distinguished from the common lobster by the absence of the huge chelæ, or claws, the anterior pair of limbs being in the nature of walking legs instead. The carapace is spiny, while the antennæ are very long, rather thick, tapering, and mounted on prominent spinous bases. In life this fine species is red instead of blue-black in colour as is the common lobster. A rather rare member of a related family, the *Scyllaridae*, is the so-called Broad Lobster (*Scyllerurus arctus*, Linn.), in which the antennæ are modified into short, broad and flat plates. A few specimens have been recorded from Cornish waters, notably in Mount's Bay and at Penzance. This interesting Mediterranean species is also known by the scientific name of *Arctus ursus*, a peculiar reversal of that of the brown bear.

Another rare crustacean recorded from Cornish waters is *Callianassa subterranea*, Mont., which has been called the Burying Shrimp on account of its habit of hiding in the sands under fairly deep water. It is a peculiar looking whitish creature with one chela very much larger than the other. It occurs only on the South coast of England. Occasionally after storms dead specimens are washed ashore;

others have been found in the stomachs of certain fish. It should be mentioned that the group *Thalassinidae* to which the families *Callianassidae* and *Axiidae* belong is now generally placed in the division *Anomura* though formerly it was always classed with the present division *Macrura*.

On the prawns the Common Prawn (*Leander serratus*, Penn.), and the Shrimp Prawn (*L. squilla*, Linn.), both belonging to the family *Palæmonidae*, are common in all the waters of these coasts, the latter in rock-pools, the former in deeper water round the rocks. Of these the common species is the larger, and may be distinguished by its longer rostrum, which is markedly serrate along its upper edge. The so-called "Pink Shrimp" (*Pandalus montagui*, Leach) is also a prawn, but belongs to a different family, *Pandalidae*. This form inhabits shallow waters along the coasts, and is often caught in shrimping nets and sold in the market. It may easily be recognized by the fact that the second leg on the left side is extremely long and slender, and out of proportion to that on the right.

The Common, or True, Shrimp (*Crangon vulgaris*, Fabr.) belonging to the family *Crangonidae* is too well known to need more than a mention in passing. Its more cylindrical carapace, flattened in front, and the absence of any rostrum at once distinguish it from the prawns. Its pincers are what is known as sub-chelate, that is to say, instead of there being two claws, as is usually the case, there is only one which folds down upon the joint to which it is attached.

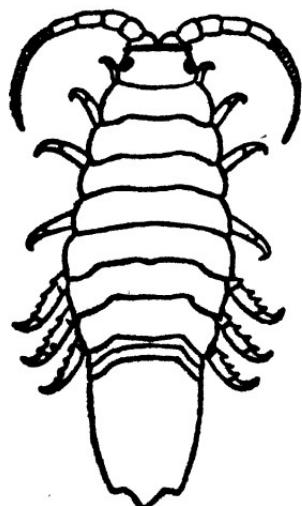
Two more members of the *Macrura* may be noticed before passing on to the numerous members of the *Amphipoda* and *Isopoda*. These are the peculiar looking creatures called Sea Mantises, of which two

species, *Squilla desmarestii*, Risso, and *S. mantis*, Rondelet, have been recorded from Cornish waters, but are very rare. In these the thorax and carapace are much reduced, the abdomen is long, wide, and flattened, and the telson, or tail greatly expanded. The claws are sub-chelate, the last joint being long and serrate on its inner edge, much as in the orthopterous insect commonly called the Praying Mantis. *S. Mantis* is a Mediterranean species, and its capture on the Cornish coast is correspondingly rare.

The Amphipods comprise the sand-hoppers, so familiar to everyone, that hide in swarms under the weeds and stones upon our shores. They are to be found in fresh-water as well as in salt, in rivers, streams, and lakes, and in the depths of the sea, especially of the Arctic. They may be described as small, laterally compressed, segmented crustaceans, with numerous appendages and sessile, or stalkless eyes. Only the two anterior segments of the thorax are fused together to form a head. There is no carapace. Two families interest us here, namely, the *Talitridæ* and the *Gammaridæ*. To these belong most of the species commonly met with on our shores.

Belonging to the former are the Common Sand-hopper (*Talitrus saltator*, Mont.) and the Shore-hopper (*Orchestia gammarellus*, Pallas), probably the two commonest species that occur on the open shore as well as in rocky places ; while to the latter belong the more freely swimming *Gammarus locusta*, Linn., and the fresh-water form, *G. piles*, Linn. The species *G. marinus*, Leach, is recorded as being more littoral in its distribution than *G. locusta*. Many more species belonging to this large group have been recorded from the district.

The Isopods may be distinguished from the foregoing by their depressed instead of laterally compressed forms. They, too, are extraordinarily abundant. To the sub-order belong the Sea Slater (*Ligia oceanica*, Linn.) a species not unlike the terrestrial Wood-louse (*Porcellio scaber*, Latr.), and one which may be found on the rocks about high-water mark. It belongs to the family *Ligiidae* which is closely related to the *Oniscidae*, comprising the purely terrestrial forms *Oniscus asellus*, Linn., *P. scaber*, Latr., *P. laevis*, Latr., *Philoscia muscorum*, Scop., and *Ph. couchii*, Bates. All these have been recorded from Cornwall, as also has the Pill Bug (*Armadillidium vulgare*, Latr.) of the family *Armadillidiidae*. *Philoscia couchii* is described as a beach loving form, and apparently it has not got very far from the semi-marine stage enjoyed by the sea slater, to which attention has already been called.



c.—*Idotea balthica*, Pallas.

Idotea balthica, Pallas. In this species the last

* Also called *Idotea tricuspidata*.

Not very far removed from these species is the little Gribble (*Limnorea lignorum*, Pathke.) of the *Limnoriidae*, that is so destructive to undersea wood-work, into which, with the Amphipod, *Chelara terebrans*, Phil., also recorded from Cornwall, it bores, eating its way till the whole substance is riddled with holes and becomes rotten.

An Isopod that is fairly common under stones and weeds amongst the rocks at Penzance, and presumably elsewhere along our coasts, is known as

segment is much larger than the others, and is three-notched and pointed at the end. Specimens secured by us were of a dark reddish-brown colour.

Several parasitic forms of Isopod are recorded, as for instance, *Ione thacica*, Mont., from under the carapace of *Callianassa subterranea*, and *Bopyrus squillarium*, Latr., from under the carapace of the prawn *Leander serratus*.

Finally we have the Cirripedia, or barnacles. Owing to their shell-like exteriors these were long classed with the molluscs, but at length it was discovered that the young in their very early stages resembled the young of the crustaceans, and then only was their true significance realized. Passing through what are known as Nauplius and Cypris stages, in both of which the animal is free swimming, the young barnacle, when in the latter stage, finally attaches itself to some firm object by means of sucker discs on the head, which becomes firmly rooted to the spot. Thereafter the barnacle develops into the familiar form to be seen all over the rocks. Eyes, head, and all are lost, while the swimmer legs, or appendages, grow into the long, tendril-like cirri of the adult. This process reminds us very much of that through which the *Tunicata* pass, and which is discussed elsewhere in these pages. The barnacle develops a shelly exterior, the tunicata a leathery test, and both degenerate, sacrificing almost everything for the security of a sedentary life on the rock to which they have become attached.

Two divisions of the sub-order *Thoracica* may be mentioned. These are the stalked Goose Barnacles *Pedunculata*, and the unstalked, or sessile, Acorn Barnacles, *Operculata*. To the former belongs the common species *Lepas anatifera*, Linn., of the family *Lepadidae*, which may be found attached to

the bottoms of ships, on wood, cork, charcoal and other solid substances; to the latter belongs the even more common *Balanus balanoides*, Linn., that is scattered all over the rocks, on the shells of the molluscs, and on the claws and shells of other crustaceans, everywhere along our coasts.

The second sub-order of the *Cirripedia* is the *Rhizocephala*, containing a group of still more degenerate and parasitic species, of which *Sacculina carcini* is a common form in British waters, and is parasitic on the common shore crab and other species. This also has the two free-swimming stages, but finally settles upon its host, penetrates the abdomen, and sends a sort of root ramifying in a network through the soft tissues of the crab, remaining itself outside as a sort of fleshy sack, headless, eyeless, legless, but developing ovaries.

CHAPTER XV

SEaweeds

And in our vacant mood,
Not seldom did we stop at some clear pool
Hewn in the rock, and, wrapt in pleasing trance,
Survey the novel forms that hung its sides,
Or floated on its surface,—too fair
Either to be divided from the place
On which they grew, or to be left alone
To their own beauty

WE may now consider for a brief space the marine algal flora of the Cornish coasts.

Elsewhere the names have been given of a few species of these interesting yet oft neglected plants, which in their entire assemblage as they grow in or round rock-pools, on the naked and exposed rocks, or below the tide marks, may be called the “wrack of the sea.” But the few species mentioned represent not a thirtieth part of the five hundred odd species and varieties of seaweed that have been recorded from Cornwall; and when it is realized that the whole of the flowering plants, ferns, horse-tails, club-mosses, and other land plants, excepting only the fungoids and lichens, that have been identified as occurring in the county is not more than 1265 species, it will be seen how rich is this algal flora that we have to consider. Indeed, it is much too extensive even to run over hastily, for which reason the present account will be limited mainly to the twenty-six species specially noted or gathered

by us in the vicinity of Penzance, though mention will be made of some of their nearest relatives that have also been recorded.

It would be as well, however, to preface our account with a few remarks on the structure and classification of the *Algæ* generally, since it is probable that to many readers of these pages they will be unfamiliar.

In the first place it must be clearly understood what is meant by the word "seaweed." Most people will have some sort of an idea of what constitutes the seaweeds, with which they are thoroughly familiar, as they bedeck the sea-washed rocks, or are washed up on the sandy foreshore, beautifying our coast-line ; but, asked for a definition, they would be completely at a loss. Now seaweeds are the marine members of the great botanical class, *Algæ*, as distinguished from the *Fungi*, or the *Musci* (mosses), or other members of the great division called *Cryptogamia*, in which the reproductive organs are primitive and hidden, or, at least, not in evidence, as they are in the *Phanerogamia*, or flowering plants.

The next question that arises is : What is an *Alga*? And to that the best answer will be to quote the definition given in the "*Encyclopædia Britannica*," which runs :

"*Algæ* may be briefly described as the aggregate of those simpler forms of plant life usually devoid, like the rest of the Thallophyta, of differentiation into roots, stem and leaf ; but, unlike other Thallophyta, possessed of a colouring matter, by means of which they are enabled, in the presence of sunlight, to make use of the carbonic acid gas of the atmosphere as a source of carbon."^o

The other *Thallophyta* referred to are the various and very numerous *Fungi*-mushrooms, toadstools, moulds, and the like. Since, however, there are undoubtedly *Algæ* that have none of this colouring matter (chlorophyll and related substances), it may be noted that the *Fungi* are believed to be descended from *Algæ*, which suggests that the latter are amongst the very oldest and most primitive forms of plant life. Just as the *Amœba* amongst animals might be called the most primitive unicellular, so certain *Algæ*, as for instance the *Protococcus*—the green scum that forms on trees—which are unicellular, represent almost the lowest form of plant life.

A step in advance of these minute spore-like forms are those such as *Vaucheria*, or *Ulothrix*, in which the plant takes the form of a long filament formed by a chain of cells.

All the higher plants, from the mosses upward, have their tissues built up of differentiated cells; but when we come to examine in minute detail such a seaweed as, say, the common bladder wrack, it will be found that its tissues throughout are made up of an agglomerate of more or less interwoven or matted filaments, or chains of elongated cells, much like the free filaments of *Vaucheria*, and the only differentiation that takes place is in the reproductive organs, where oogonia, or female organs, and antheridia, or male organs are produced in little sack-like conceptacles. The stem, the root and the frond are all built up of these filaments and chains of cells, and, whenever they come under the influence of sunlight, the colouring matter contained in them functions, as does the chlorophyll of the higher plants. The roots are not true roots capable of absorbing nutriment from the substratum,

but are merely adhesive or anchoring organs ; there are no true leaves, though certain parts of the plant assume a leaf-like appearance ; while the stem is not in the least like that of a flowering plant, or even of a fern, with their vascular systems.

The *Algæ* have been divided into four main groups, according to the nature of the colouring matter contained in their cells, which grouping corresponds with the somewhat different reproductive organs and modes of reproduction in the various species.

These four groups are :—

1. *Cyanophyceæ*, or Blue-green *Algæ*, which are characterized by the addition of a blue colouring matter called " phycocyanin " to the chlorophyll of the cells. As none of the species to be discussed here belong to this group, it need not be further considered, except to note that to it belong the very lowest algal forms, in most of which the only method of reproduction is that known as vegetative, i.e., simple cell division. Blue-green *Algæ* occur everywhere—on rocks, trees, damp soil, in salt and fresh water, on snow in Arctic regions, and in hot-springs.

2. *Chlorophyceæ*, or Green *Algæ*, in which there is no other colouring matter than the chlorophyll. This group is again divisible according to modes of reproduction into :—

- a. Conjugateæ, e.g. *Spirogyra*.
- b. Euchlorophyceæ, e.g. *Ulva* and *Conferva*.
- c. Characeæ, e.g. *Vaucheria* and *Volvox*.

Many of the species belonging to it are filamentous, some membranous. The group is far more abundantly represented by fresh-water species than by marine forms, in fact, the bulk of the fresh-water *Algæ* belong to it. Vegetative, asexual, and sexual

reproduction take place in the group, but mostly the two former.

3. *Phaeophyceæ*, or Brown *Algæ*, which are characterized by the presence of a brown colouring matter called "Phycophæin" in addition to the usual chlorophyll. To this group belong all such well-known forms as the bladder wrack (*Fucus*) and ribbon-weed (*Laminaria*). The group is pre-ponderantly marine, or rather littoral, in its distribution, only one fresh-water form occurring in Cornwall, and very few elsewhere. Reproduction is mainly sexual.

4. *Rhodophyceæ*, or Red *Algæ*, which are characterized by the presence of red colouring matter called "phycoerythrin" in addition to chlorophyll. To it belongs all the beautiful red, pink, and purple seaweeds that display their vivid colours along our rocky coast, such, for instance, as *Corallina*, *Gracilaria*, *Lomentaria*, *Chondrus*, *Gigartina*, and *Porphyra*. It, too, is abundantly marine, and contains by far the greater majority of the species of seaweeds along the coasts of Cornwall, as well, of course, as of other coastal regions. A few fresh-water species have been recorded from the country. Paradoxically, all Red *Algæ* are not red, some purely green species being known. Reproduction is mainly sexual, though there is a considerable amount of asexual reproduction, while the former method may be said to have attained the highest specialization in these seaweeds.

It is impossible to go into details here regarding the many modes of reproduction prevalent amongst the *Algæ*; but briefly it may be stated that, by *vegetative* reproduction is meant the simple dividing into two of the unicellular forms, or the budding off of new plants from the old in the multicellular

forms ; by *asexual* reproduction is meant the development of what are called "zoospores," or minute, naked, free-swimming, non-sexual spores, each provided with flagellæ, or motile hairs, and which, after a period of active swimming about, come to rest on some substratum, become encysted, and by simple cell division develop each into a new plant ; and by *sexual* reproduction is meant the development of sexual spores, or gametes, called true spores (female), ova, or oospheres, and spermatozoids (male), or antherozoids, the latter obtaining access to the former, which they fertilize, each fertilized spore developing in due course into a new plant. In the brown seaweeds the antherozoids are motile, but in the red the spermatozoids are not. It may be added that a very prevalent asexual mode of reproduction in the red seaweeds is by what are called "tetraspores," which are non-motile ; and amongst certain gametes of the Green *Algæ*, in which the sexes are not differentiated, conjugation, or the coalescing of two individuals, sometimes takes place. Another point requiring mention is that in the species where sexual reproduction takes place, sometimes the sexes are developed in different plants, when the species is called "dicœcius," sometimes both sexes in the same plant, when the species is called "monoœcius."

An interesting feature in connection with the wrack of the sea-shore is that it occurs in zones, each characterized by some particular species, or group of species. This of course will only become evident at low tide and in places where gradually descending rocks extend from above high-water mark down to beyond low-water mark. First there are the Zone of exposed rocks and that of the rock-pools, and it will be seen at once that the brown

sea-weeds of the *Fucus* group predominate in the former, while in the latter such red seaweeds as *Rhodymenia palmata* and *Gigartina mamillosa*, and, in the lower pools *Corallina officinalis* clothe the sides. This at once suggests that the brown seaweeds are more able to withstand exposure to the air than the red, a fact which further investigation confirms. But, looking more closely, we find that the brown seaweeds themselves show a distinct zonation in the sites they choose in relation to high and low tide. These have been observed and may be set down for a sheltered situation like that of Penzance as follows:—

1. The *Pelvetian* Zone: from high-water mark to a little way below it. Characterized by the predominance of the Channelled Wrack (*Pelvetia canaliculata*). In exposed places *Fucus spiralis* predominates.
2. The *Fucus* Zone: from the *Pelvetia* zone to mid-tide mark. Characterized in descending order by the Common Wrack (*Fucus platycarpus*), the Bladder Wrack (*F. vesiculosus*), the Knotted Wrack (*Ascophyllum nodosum*) and the Serrated Wrack (*F. serratus*).
3. The *Himanthalian* Zone: from mid-tide mark to about low-water mark. Characterized by the Sea-thong (*Himanthalia lorea*).
4. The *Laminarian* Zone: about and below low-tide mark. Characterized by the Fingered Ribbon-weed (*Laminaria digitata*), the Bulbous Ribbon-weed (*Saccorhiza bulbosa*), and others.

Below the *Laminarian* zone comes the true Red *Algae* zone, extending downward to the limit of marine plant life, which is reached at a depth of 150 feet. As already indicated it extends upwards to above half-tide mark, but mainly in the rock-pools,

for the red seaweeds are mostly unable to withstand exposure to the air and the effects of desiccation. As a matter of fact, they also occur in the Himanthalian zone as a sort of undergrowth, being protected by the tangle of thick brown algal growth. The highest pools are mainly occupied by various kinds of Green *Algae*. Thus we could make out sub-zonation of the rock-pool zone, which could be called (1) the Green Seaweed zone, above half-tide mark, (2) the *Gigartina mamillosa* zone, about half-tide mark, and (3) the Coralline zone below that ; but this would be stressing the point almost too far.

The exact cause of this zonation does not appear to be quite clear. It has been suggested that the red seaweeds occupy the comparatively deep waters, because owing to their colour, they may utilize the light rays belonging to the violet end of the spectrum, which, as is well-known, are those that penetrate deepest into the sea. All the *Algae* need sunlight, as was indicated in the definition of the group quoted at the beginning of this chapter, and none can exist except where, in the words of Thomson,

“ The penetrative Sun,
His force deep darting to the dark retreat
Of vegetation, sets the steaming power
At large.”

But the case is different with the brown seaweeds, which may, apparently, occupy the rocks that are exposed every few hours by the ebb of the tide by reason of their toughness and power to withstand the effects of desiccation. The same applies also to the green seaweeds, whose powers in this direction are often even more marked. We must leave this fascinating phase of our subject, however, in order to consider in detail some of the weeds themselves.

Enough has been said to show where lies a probable very fruitful field of research for the investigator who will undertake to examine in detail the sites usually occupied by each of the more conspicuous species, and to correlate them with its structure and habit of growth.

As already stated we collected during our stay in Penzance specimens of some twenty-six species of seaweed. Of these four belong to the green seaweed group, or *Chlorophyceæ*, eleven to the brown, or *Phæophyceæ*, and eleven to the red, or *Rhodophyceæ*. As they represent some eleven orders, and are all fairly common, a short survey of them will serve, not only as an introduction to the subject of marine *Algæ* as a whole, but to assist the beginner in the collecting and studying of the members of this interesting branch of botany.

Commencing with the green seaweeds, it may once more be stated that in this group reproduction is mainly by means of the formation of zoospores. The protoplasm of certain cells undergoes a change, ultimately dividing up into segments, which assume the form of pear-shaped motile spores, provided with a number of cilia or flagellæ, the rapid movement of which propels the spores through the fluid medium that surrounds them. These escape from the cell, and after a period of activity settle on some stable object and develop into new plants by growing out on either side. On one side grows an attachment organ, on the other a filament, or a membranous frond. Where conjugation takes place the zooids or spores are smaller, and though sexual, show no differentiation of sex. This may be called the most primitive form of sexual reproduction.

Three species of green seaweed belonging to the order *Ulvaceæ* are very plentiful between tide marks

on the Cornish coasts, especially in the vicinity of harbours and towns. The members of this order are characterized by having a bright grass-green membranous frond composed of one or two layers of minute rounded cells. Reproduction takes place

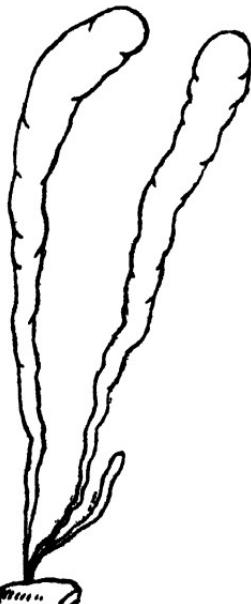
by means of Zoospores. The Broad Ulva, or Sea-lettuce, (*Ulva latissima*, Kütz.), an extremely common form occurring abundantly on the stones in such places as the bottom of the harbour at Penzance, may at once be recognised by its wide, irregularly shaped frond, which is attached to the stone or rock by means of a very short, slender stalk, and a small adhesive

disc. The frond may be branched, has a very crinkled or wavy margin, and attains a maximum length of about two feet, and a width of a foot.

The Intestine Enteromorpha (*Enteromorpha intestinalis*, Link.) is similar to the sea-lettuce in consistency, colour, and fructification ; but in form is an elongated sack, tapering at its base, broader and rounded at its distal extremity. The membrane is one cell in thickness, not two-celled as in the sea-lettuce. The Flattened Enteromorpha (*E. compressa*, Grev.) differs from *intestinalis* only in being more slender, smaller,



A.—Sea Lettuce (*Ulva latissima*, Kütz.).



B.—Intestine Enteromorpha (*Enteromorpha intestinalis*, Link.).

and in having the frond somewhat flattened and branching. Both these species are very common, and may be found growing generally on loose stones and rocks in rock-pools or wherever these may occur. The explanation of this is that these weeds are of very rapid growth and so appear at once even on a substratum that is subject to removal or to being rolled over by a heavy sea. The slower-growing weeds do not get a chance to produce a crop before they get knocked off and crushed. These, however, seem to keep the green weeds from developing on the immovable rock surfaces ; while it has been found that in the vicinity of drains, where, probably, the brown and red seaweeds cannot thrive, such forms as *Ulva* grow in great profusion. Thus we see that even in the plant world there is a keen competition between the different species, and when a certain type is suited to a certain position, we usually find it dominant there, till some chance occurrence favours another, or is harmful to it, when it is at once replaced.

The Rock Cladophora (*Cladophora rupestris*, Kütz.) is the green weed that grows in dense beard-like masses on smooth rocks, and helps to make them so slippery. It is of a rich dark green colour. The somewhat elongate cells of this species withstand desiccation to a remarkable degree, the plant recovering easily from a prolonged exposure to the drying influences of wind and sun. Its frond is tufted and formed of jointed and branched filaments. Reproduction is by zoospores. Of this genus of Green *Algæ* many other species have been recorded from our district, as well as of the two foregoing genera ; while the whole group is represented by well over fifty forms in Cornish waters, including

the genera *Briopsis*, *Vaucheria*, *Codium*, *Rhizoclonium*, *Chætomorpha*, and others, all of which are more or less filamentous in form, except *Codium*, whose species may be bulbous, as in *C. bussa*, or long, cylindrical, or flattened, and branched, as in *C. tomentosa*.

It is probable that of all marine *Algæ* the brown seaweeds are most familiar to the general reader, and of them all the members of the orders *Fucaceæ*, or wracks, and *Laminariaceæ*, or ribbon-weeds, will be best known. Indeed, these form the mass of the heavy algal growth on the rocks between tide marks all round our coasts. To the *Fucaceæ* also belongs the far famed Gulfweed (*Sargassum bacciferum*), that occurs in dense floating masses in the mid-Atlantic Ocean, extending for thousands of square miles, and specimens of which are sometimes carried by the Gulf stream and cast upon the coasts of Great Britain.

Without going too much into detail, it may be stated that amongst the brown seaweeds, reproduction takes place by means of the development of female spores, corresponding to the ova in higher plants and called oogonia, containing a varying number of oospheres, which are fertilized by motile antherozoids, developed in antheridia, both the oogonia and antheridia being contained in little sack-like conceptacles, usually in some specially developed part of the frond called the receptacle. The antherozoids are very like the zoospores of the Green *Algæ*, already described, and swim rapidly through the water by means of two cilia. The oospheres are much larger, rounded, and quiescent. The species of brown seaweeds may be either dicecious or monoecious, most frequently the latter.

As a typical example of the Brown *Algæ* the

common Bladder Wrack (*Fucus vesiculosus*, Linn.) may be taken. In this well-known species there are root, stem, and frond, the latter being branched, laminar, having a thickened midrib, plain margin, and air sacks, or bladders, arranged in pairs along the blades. The reproductive organs occur in specially developed, sometimes forked, bladder-like receptacles at the ends of the branches of the frond, and are covered with little protuberances, inside each of which is a conceptacle. When "ripe" the small openings of these sacks may be seen to exude an orange-yellow substance, which contains the antherozoids and spores.

In the Serrated Wrack (*F. serratus*, Linn.) there are no air-bladders, the margins of the somewhat broader blades of the branched frond are serrated, and the spore receptacles are flatter than in the bladder wrack, though terminal.

The Knotted Wrack (*Ascophyllum nodosum*, Le Jolis) presents a somewhat different fructification and appearance. In it there is practically no blade to the frond, this being all branched stalk, so to speak, with single large air-bladders at intervals along the whole length. The spore receptacles grow in the form of club-shaped bladders from joints towards the ends of the stem and branches. The whole plant is very tough and leathery in texture, more so than the two foregoing, which themselves are very much of this nature. The frond may attain a length of as much as five feet, and is usually overgrown with various algal parasites, especially the filamentous red seaweed *Polysiphonia fastigiata*. The spore receptacles when ripe are of a bright yellow colour.

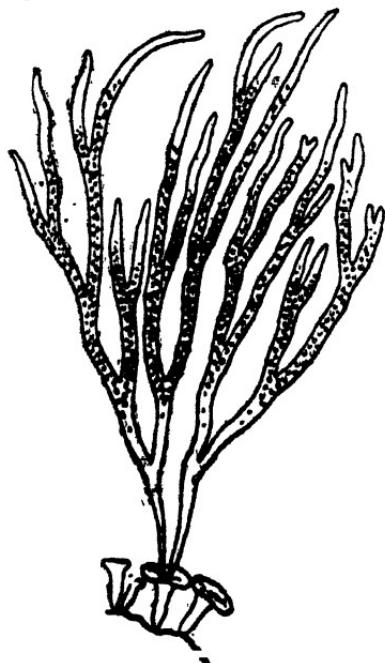
In the little Channelled Wrack (*Pelvetia canaliculata*, D. & Th.), which grows in dense tufts on

the rocks in the region of high-water mark, the much-branched frond is not very wide, there is no mid-rib, and a channel runs down one side, while the spore receptacles grow at the ends of some of the branches as twin, elongate bladders. This is a small plant usually of an olive-yellow colour.

The Sea-thongs (*Himanthalia lorea*, Lyngb.) is a very peculiar weed, with an interesting form of growth. It begins as a small nail-like growth with a hollow stem and a small saucer-shaped head. This is the frond. In the centre of the saucer, as the plant increases in size, appear two small white pimple-like lumps, which gradually develop into two long, flattened thongs. These branch and rebranch by forking at rather long intervals, till long strands are formed. It is in these that the spore conceptacles occur scattered along their whole

length, so that they must be considered as corresponding to the receptacles in the weeds already noticed. Growing fairly low down on the rocks, this species is very common at Penzance.

In the pools fairly low down may be found large bunches of the Heath-like *Cystoseira* (*Cystoseira ericoides*, C. Ag.). When submerged this is one of the most beautiful of our sea-weeds, for then its heather-like fronds, growing in dense tufts, display a wonderful iridescent blue



c.—Sea Thongs (*Himanthalia lorea*, Lyngb.).



(Photo by A. de C. Sowerby)

A jungle of marine weeds a little above low-water mark. The stone is covered with beautiful grass-green *Enteromorpha*, while *Himanthalia*, serrated wrack, and *Laminaria* fill the foreground.



(Photo by A. de C. Sowerby)

The Laminarian Zone, at and below low-water mark. When exposed the rocks are found to be a mass of huge ribbon-weed.

colouring, which vanishes as soon as the plant is taken out of the water. If examined closely it will be found that the fronds are formed of much branched stems with small spine-like branchlets, while the spore receptacles are spherical with spine-like points, and are set close together along certain parts of the stems. Each appears to contain but one conceptacle. Small air-vessels occur sparsely towards the tips of the branches. We found this plant growing amongst the tangles of *Laminaria* just above low-tide mark. It and the fore-going five species all belong to the order *Fucaceæ*.

Of the *Laminariaceæ*, or ribbon-weeds, we have three species to consider here. The so-called Sugared Ribbon-weed (*Laminaria saccharina*, Lamour.) is probably the best known. It is the species that occurs in long ribbon-like fronds with a rounded stalk and branched roots, which, dried and hung up on a wall, is used as a barometer to foretell weather conditions. The spores are produced on the surface of the long, unbranched, crinkly-edged frond.

In the Fingered Ribbon-weed (*L. Digitata*, Lamour.) the frond is wider and thicker, and is deeply cleft into long fingerlike strips, from which fact the plant gets its name. The stem is long, rounded, and tough.

The Bulbous Ribbon-weed (*Saccorhiza bulbosa*, De La Pyl.) has a wide, flattened stem, with a crinkly, laminate margin, the frond being cleft into strips much as in the foregoing form. Its distinguishing feature is the presence at the base of the stem of a large hollow tuber, studded with numerous peculiar protuberances or knobs. This species grows to an immense size.

A weed that will always attract attention is the

Cord Weed (*Chorda filum*, Stuckh.), which looks exactly like a long porpoise-hide bootlace. Cylindrical, it tapers away towards both ends, attaining a length of as much as thirty or forty feet. It is very slimy. The fructification is distributed along the length of this peculiar frond. The plant may be found growing about the region of low-water mark on rocks along with *Himanthalia*, as well as in deeper water. It belongs to the order *Chordaceæ*.

At a casual glance, and but for its brownish colour, our next species, *Pylaiella littoralis*, Kjelhm., would never be suspected of belonging to the same group as the *Fuci* or *Laminariæ*. A member of the order *Ectocapraceæ*, in which the fronds are branched and thread-like, and the spores are attached to, or embedded in, the small branches, it has much more the appearance of, say, the rock cladophora of the Green *Algæ* group. It grows in similar places to the latter, and is even more common. Its colour is greenish-brown when young, becoming browner with age. It is the brownish hairy growth that covers the sea-washed timber of piers and wharfs so thickly. It also grows on other large weeds, such as the serrated wrack or ribbon-weed, and may attain a length of a foot or more. If examined closely it will be noticed that there are slight swellings in the substance of the branches called pods, and it is usually by the position and shape of such pods that the members of this order are distinguished.

The last group of seaweeds, the Red *Algæ*, with which we have to deal, differ from the foregoing in their modes of reproduction in that not only are the sexual organs present, but also what are called tetraspores. These are something like true

spores, but differ in that they are capable of developing into new plants without being fertilized. An interesting point about these tetraspores, so called on account of their division into four parts instead of the two usual in cell division, is that they and the sexual organs occur on different plants, so that in case of a dioecious species we have three different types of plant instead of two. When present the tetraspores occur scattered singly over the whole frond, in external warts called nemathecia, in receptacles called sporophylla, or in pod-like receptacles called stichidia, according to the species of the mother plant. The true spores are nearly always arranged in bunches or clusters, sometimes in conceptacles. The male spores are called spermatozoids and are not motile, as are the antherozoids of the brown seaweeds, but are carried in the fluid medium that surrounds them, only reaching the ova, as it were, by accident.

A seaweed that used to be classed with the Green *Algæ*, but is now known to belong to the present group, goes by the name of *Porphyra laciniata*, Harvey. It is variously coloured purple or olive-brown, and in appearance much resembles the sea-lettuce (*Ulva latissima*). It has a broad, rather delicate membranous frond, with irregular and crinkled margins, often divided. Its colour at once serves to distinguish it from *Ulva*. The spore-bearing cells occur in groups of four all over the frond and it is to their purple colour that the plant owes its shade. Before they are properly developed, or after they are dispersed the plant is brownish or olive. The species belongs to the order *Porphyraceæ*, which is represented on the Cornish coast by several genera.

Of the order *Gigartinaceæ*, we secured some four

species, of which the best known is undoubtedly the so-called Irish Moss, or Carragheen (*Chondrus crispus*, Stackh.), from which is extracted by boiling Carragheen Gelatine. Of a beautiful purplish crimson colour its flat frond, growing from a flattened stalk, divides repeatedly, forming in the end a dense tuft. Spread out the frond may be described as fan-shaped. The spores occur in oval clusters in the substance of the frond. This species grows in deep pools very abundantly, and also in deeper water below tide-marks. Quantities of it are washed ashore at places like Penzance.

Somewhat similar in the shape of its frond to the foregoing is the deep reddish-purple Mamillose Gigartina (*Gigartina mammillosa* J. Ag.), which has already been mentioned as forming a characteristic feature of one of the rock-pool algal zones. In this species the much-divided, fan-shaped frond is studded all over its surface with small mammae-like processes, in which are lodged the spore conceptacles. The stem is channelled, by which feature barren plants may be distinguished from specimens of Irish Moss, which they otherwise resemble.

Callophyllis laciniata, Kutz., occurs commonly on the Cornish coast, and being of a bright crimson colour will catch the collector's eye, as it floats with the loose wrack at the water's edge. It grows in deep water on rocks or on the larger ribbon-weeds. The frond is very flat, much cleft, fan-shaped. The minute spores occur in conceptacles in small leaflets at the margins of the frond, while the tetraspores are scattered through its substance in cloudy patches.

The Purple Cystoclonium (*Cystoclonium purpurescens*, Kutz.) is of very different appearance from the foregoing, the slender stem and numerous

branches being almost filamentous. The spores are in conceptacles buried in the branchlets, but are very difficult to find. The tetraspores occupy the same position in the individuals in which they occur.

The order *Sphaerococcaceæ*, so called on account of the bead-like spore-threads (spore containers) which occur at frequent intervals along the slender branches of the fronds of some of its members, is represented in our list by two species. One of these, *Calliblepharis ciliata*, Kutz., has the frond broad, flat, and branched, the margins fringed with narrow leaflets, in which are buried the spore conceptacles. The stem of the frond is rounded, the root fibrous.

The tetraspores are scattered through the substance of the frond in cloudy patches, much as in *Callophyllis*, which this plant also resembles in its brilliant crimson colour, and the distribution of the spores.

The second species is the beautiful *Gracilaria confervoides*, Greville, in which the frond consists of long slender branches and branchlets, with the spore-threads conspicuous. It is of a dull reddish colour, and occurs all round the coast.

Belonging to the order *Rhodymeniaceæ* are three species for our consideration; all three exceedingly beautiful. The first, *Rhodymenia palmata*, Grev., is the deep red, or purplish-red, flat palmate-fronded



D.—*Calliblepharis ciliata*, Kütz.

species that grows commonly on the sides of rocks and rock-pools from below half-tide mark to low-water. It is one of the few red seaweeds that can survive being left exposed by the receding tide, a fact which is doubtless due to its leathery consistency. Its leatheriness increases with age, while the frond may grow to a considerable size. Its margins are sometimes provided with little leaflets. Reproduction is mainly by means of tetraspores, which are scattered over the whole surface of the frond buried in its substance.

The Jointed Lomentaria (*Lomentaria articulata*, Lyngb.) may at once be recognised by the jointed nature of its much-branched frond, the branches being somewhat slender and not flattened. It is of a bright red-colour.

Plocamium coccineum, Lyngb., might well be considered the most beautiful of the commoner species of red seaweed to be found on these coasts. Its frond consists of numerous somewhat flattened branches and small branchlets ; its colour is rich crimson. It is extremely abundant and should be well-known on account of its beauty, for its branching and colour are very elegant. The spores occur in solitary conceptacles on the margins of the frond, while the tetraspores occur in leaf-like stichidia.

Easily distinguishable from any of the foregoing by the banded appearance of its long slender thread-like branches, caused by minute jointing, is the beautiful red *Ceramium rubrum*, Ag. This weed belongs to the order *Ceramiaceæ*, and is very common. In its fructification the spore-clusters are enclosed in a transparent stalkless sack, which is set on a branch and is surrounded by a fringe of short branchlets. Tetraspores also occur in this species.

We have already referred to a somewhat filamentous weed of a brownish-green colour that grows on the knotted wrack (*Ascophyllum nodosum*). This is *Polysiphonia fastigiata*, Greville, of the order *Rhodomelaceæ*, and, since it introduces us to an interesting group of weeds, it may be briefly described here. In it the frond consists of branched filaments, which are jointed, and are composed of tubular cells. The plant grows in tufts of from an inch to two inches in length. It belongs to a very large genus, some twenty odd species and varieties having been recorded from Cornish waters. In this species the spores are contained in stalkless conceptacles, the tetraspores being embedded in the terminal branchlets.

Finally we come to what by some might be considered the most beautiful of all marine *Algæ*, namely the lovely little Coral-weeds, of which the species *Corallina officinalis*, Linn., was gathered by us from the rocks at Penzance. The order *Corallinaceæ* to which this species belongs, contains many genera, some seven of which, represented by sixteen species and varieties, are recorded from Cornwall. But we need be concerned only with the one, which may be described as a rather small, much branched plant of a purplish-pink colour, and segmented appearance. On examination it will be found that the stems and branches consist of a vegetable substance surrounded by wedge-shaped sections of calcareous matter, which give the plant more the appearance of a coral of some sort, and consequently its name. This calcareous matter, Carbonate of Lime, to be exact, is secreted from the cells of the stem and branches. The plant grows in dense clusters on the sides of rock-pools, under the water, and on the larger weeds ; its colour when well away

from the light being deep purple, but becoming lighter as it is more exposed to light. In its fructification club-shaped spore-cells occur in ovate conceptacles, which are formed from a terminal joint, or on the surface of the frond.

With these brief and all too fragmentary descriptions of a few species of seaweed we must leave the subject; but it is felt that enough has been said to show what a wonderful variety of beautiful and interesting forms this particular flora presents. Indeed, the student of Nature, who decides to devote his time and energies to the marine *Algæ* of our coasts will not only find plenty to do, but will be amply rewarded in many ways for his efforts.

CHAPTER XVI

SEA GULLS

ONE of the most attractive features of the seashore, whether of the open beaches and sand-flats, the river-mouth, the rugged rock-wall, or the chalk cliff, are the gulls, whose plaintive or garrulous calls are ever to be heard above the dull boom of the breakers, or the roar of the storm, whose graceful forms, grey and white with markings of black, are always to be seen wheeling overhead, floating out upon the off-shore waters, crowding upon the low-lying rocks, or busily scouring the wet beaches for their food, the debris of animal matter left by the ebb-tide.

Watch them now as they sit upon the low rocks, preening their snowy breasts, combing with their bills their long pinions. The tide is on the turn, and they are waiting for it to go right out. They begin to get restless. One bird after another stands up, stretches its wings, legs and neck, utters a series of loud not unmusical, but wholly derisive, cries. Then the whole flock rises in a cloud, the many white forms—for they all look white when in flight, except the immature birds, whose plumage is universally dull greyish speckled with dusky or brown—crossing and recrossing in wild confusion, as away they go in a disorderly rabble, finally settling along the water's edge on the sands. In their flight is often little enough of the fine regularity

and almost military precision of the wild-fowl, ducks, geese and the like, whose V-shaped formations must ever appeal to the wonder of the sportsman as he waits, gun in hand, in the cover of the reeds on the marshes, or, perhaps, on the foreshore, carefully concealed behind some rough shelter. Occasionally, however, when on a long flight gulls will drop into this formation, which makes all the more remarkable their disorderliness at other times.

See them now strung out along the shining levels of the beach, hunting, running here and there in short, quick dashes, pursuing for short distances those amongst their number that have been lucky enough to pick up some succulent morsel. Note the way the smaller birds keep out of the way of that large black-backed fellow. Gulls may appear harmless enough, but their looks belie them. Some dark deeds, indeed, are attributable to some of the larger ones, such as the herring-gull and the black-backed gulls, not to mention the beautiful glaucus gull, and well do the smaller species such as the kittiwake and black-headed gull know it.

As the tide begins to flow once more, our birds keep just ahead of the incoming waters, still eagerly searching the foreshore and shallows, for many forms of marine life are now astir and are easily discovered and snatched up by the hungry feeders. During the flood tide is the period of greatest activity in the shallow waters. Many creatures that had hidden in the sand as the waters fell away now come to the surface to welcome their return, and—the gulls get them.

At last the waters reach the shingles, and then the gulls either fly out into the bay, or hie them off to some other feeding grounds. It is no use waiting on the shingles unless the weather be rough, when

of course, all kinds of delectable fare is cast up by the angry waves.

A favourite feeding place of the gulls is the sea-ward terminus of some large drain, and, where such occur, one may always count on seeing large numbers of gulls, who are by nature first class scavengers, for all their beautiful white plumages. If they have had their fill, they retire to some favourite resting place. In Penzance, for instance, the local gulls love the roof of the station shed below the passenger station, and there some may be seen at almost any time of the day. Sometimes the whole roof is covered with them.

The harbour at Newlyn offers a splendid place to study the gulls; for many species congregate there owing to the proximity of the fish-market. There is always fish-debris to be had, the waste product of the sheds where the fishermen dispose of their nightly catches, and the useless parts of such fish as skates, sharks, and anglers are thrown into the harbour. At low tide or thereabouts, the bottom of the harbour may be seen to be strewn with the remains of fish, which, when the water is sufficiently shallow, are dragged up by the gulls and fought over ere being devoured. It is very amusing to watch the antics of the birds as they struggle with a large piece of skate or the head and spine of a dogfish, tough fare at the best. If a piece of loose flesh is detached, the lucky possessor must make haste to dispose of it, or it will be snatched from him. Swallowing frantically, the harassed bird twists and turns in an effort to keep his back to his greedy companions, or, with the choice morsel in his bill, he endeavours to rise from the water and fly to some safe retreat. He is at once chased by larger birds hovering overhead,

and waiting for just such a contingency. As often as not the coveted prize is dropped, and at once there is a wild rush and scramble on the part of all the other gulls ; and so it goes on till some bird more greedy than the rest succeeds in giving the delicacy safe repository within his capacious crop.

That gulls themselves are open to amusement and merry jest may be gathered from watching them at play, as when they indulge in " I'm the king of the Castle." The top of a tall mast or a flag-pole on the breakwater, serves as the " Castle," and one may watch the birds each in turn pushing, or trying to push, the others off. One bird alights on this eerie perch, extends his neck, uttering loud and apparently derisive calls, as he gradually brings his head down between his feet. The challenge—for such it appears to be—is soon taken up by another bird, who comes sailing along straight at the challenger. If the latter holds his ground, the other rises at the last moment over his head, circles, and swoops again. As often as not the challenger fails to withstand the charge, as the attacker heads for him like a bolt from the blue, and, leaping lightly into the air, leaves the " Castle " for the other to possess. This sort of play seems very popular with the gulls, and is practiced frequently. The jeers that each new possessor of the coign of vantage hurls at the dispossessed suggest that there is something more in the matter than the mere desire for a comfortable perch : there is evidently some mind-play at work.

Birds are essentially creatures of a high order of intelligence, far superior in this direction to most mammals. Watch a gull that has picked up a mussel on the shore, the living animal safe within the two tough valves of its shell. With the

(Photo by G. L. Green - Son Perman)

The Herring Gull watching for its prey in the form of smaller sea-birds returning to their nests with food for their young



mollusc in his bill he will rise in the air and let it drop upon the shingles, sweeping down after it to seize the soft animal whose armour has thus been shattered. I have seen this done over and over again, and cannot think it represents anything less than a process of reasoning from cause to effect. To call it instinct does not help the case. At some time or other some gull discovered that was the only way to get the soft tissues of the mussel, and whether he taught his progeny the trick, or it was discovered anew by each succeeding generation of gulls till it became a fixed faculty matters little. What is important is that it is a mental accomplishment and not an adaption of some part of the body to its environment. The more one looks into the lives of the members of the feathered world, the more is one struck by their extraordinary mental attributes. The jackdaw's love of bright objects, for instance, and its habit of hording them, or the bower-bird's bower, which it builds apparently for no other purpose than to play in, decorating it with shells, pebbles, gay feathers, and what not. These serve no useful purpose; they are not necessary to its livelihood. They are the expression of an æsthetic faculty, which all birds possess in a greater or lesser degree. Another is the dancing of certain plovers and cranes, and another the peculiar tumbling evolutions of the golden eagle as it and its mate circle and soar high above the mountain tops. And this brings us back to our gulls.

What a wonderful thing is their flight! No one who has stood at the stern of a great ocean liner, with its eighteen knots an hour, and watched the gulls keeping up with the great vessel, now forging ahead, now dropping back, and now overhauling it again, all with scarcely a wing beat and no apparent

effort, can fail to have been struck by the wonder of it. Here, indeed, is a mystery awaiting solution. Undoubtedly the birds are utilizing the wind in some way, but how? Many explanations have been offered, but none that one has read are convincing.

According to the records only four species of gull are resident in Cornwall, though, with regular winter visitors, casual visitors, and stragglers, the list of Cornish gulls consists of a round dozen species.

Naturally the resident species will prove most interesting to the summer visitor, for they are the only ones he is likely to see. They are the Herring-gull (*Larus argentatus*, Gm.), the Kittiwake (*Rissa tridactyla*, Linn.), the Great Black-backed Gull (*L. marinus*, Linn.), and the Lesser Black-backed Gull (*L. fuscus*, Linn.).

Of these the kittiwake is extremely plentiful at Penzance, in Mount's Bay, and at Newlyn during the summer. It breeds along the cliffs at various places along the south coast, from Falmouth westward. It is the small gull that is so common in these parts during the summer, and is not to be confused with the Black-headed, or Laughing Gull (*L. ridibundus*, Linn.), which is a winter visitor only, and at that season loses its characteristic dark cap and mask, nor yet with the Common Gull (*L. canus*, Linn.) another winter visitor of about the same size and general appearance. The kittiwake has the hind toe so reduced in size as to be almost wanting, hence its specific name, which means "three-toed." It has a pale yellow bill and almost black legs. In the common gull the bill is greenish-yellow, the legs greenish. In the black-headed gull, the bill is dark crimson, the legs bright crimson; while in summer it is at once distinguishable by its dark, blackish-brown head. Even in winter there is a



(Photo by Graham C. Sargeant, Pinetree.)

Newly-hatched young of the Herring Gull

dusky patch on the side of the head that readily distinguishes it from either of the other two. This is the gull that commonly visits inland rivers and even artificial lakes during the winter, at which time, because it has lost its black cap, it is usually called and mistaken for the common gull. It nests mostly in inland marshes, and is never to be found at sea far from land.

The kittiwake builds its nest of seaweed and grass upon some ledge on the cliffs; two or three eggs being laid. Incubation takes place in June, the young leaving the nest some time in July. Late in August, or in September the birds take to the open sea, forsaking the cliffs they infested during the spring and summer.

The herring-gull is equally common with the kittiwake round Penzance and Newlyn during the latter part of the summer and early autumn, indeed, it is common at all times, even during the incubating and young rearing season. It nests all round the Cornish coasts, but especially on the Scilly Isles. There mid the most beautiful surroundings, where the tussocks of sea-pinks grow thick, and just when the plant is in full bloom, the herring-gull builds its loose nest, between the very tussocks. Three rather large eggs are laid, and in due course the fluffy, speckled fledglings appear.

Apart from its size, which is considerably greater than that of the kittiwake, the adult herring-gull may be distinguished by its pale pink legs and yellow bill, the latter with a red blotch at the tip of the lower mandible. From the black-backed gulls it may at once be distinguished by its pearl-grey mantle and wings, the primaries of the latter being black with white tips. It is a very noisy bird, and has many different calls, or series of calls. It frequently

flies inland, where it may be seen on ploughed fields, moors, or hovering over inland waters.

Of the black-backed gulls the lesser is the more common. It is slightly smaller than the herring-gull, which it otherwise resembles, except for its yellow legs and dark, blackish-grey back, mantle, and wings. It is said to nest abundantly on the Scilly Isles, as well as commonly at various places round the coast. It builds its nest on cliff-ledges.

The great black-backed gull is a large edition of the foregoing species, from which it differs only in considerably greater size and in having pink instead of yellow legs and feet. This large bird may be seen, generally singly, sometimes mixing with the flocks of herring-gulls and kittiwake, all round the Cornish coasts. It breeds in the Scilly Isles and on the mainland, nesting on the ledges of cliffs. Its nesting range extends along the south coast of England, where it occurs but sparingly, however, but does not include the east coast. It is plentiful on Scottish coasts, less common on the Welsh coasts, and plentiful on the western and northern coasts of Ireland. It will thus be seen that Cornwall is the breeding haunt of many species of sea-fowl not common to other parts of England.

The great black-backed gull uses its strength and power to harry the lesser sea-birds, killing and partially devouring such species as the guillemot and puffin, which it strikes down in mid air as they fly to and from the cliffs.

Other gulls not already mentioned that visit the Cornish coasts are the large and beautiful light coloured Glaucus Gull (*Larus glaucus*, Fabricius), an occasional winter visitor; the Iceland Gull (*L. leucopterus*, Fabr.), which also has the primaries white, but is somewhat smaller than the foregoing,

also an occasional winter visitor ; the Little Gull (*L. minutus*, Pall.), with a black head, and further distinguishable on account of its small size ; Bonaparte's Gull (*L. philadelphia*, Ord.), a straggler from America ; and Sabine's Gull (*Xema sabini*, J. Sabine) another black-headed species, distinguishable by its forked tail. The last three species must be placed in the category of accidental stragglers the little gull being an eastern form that appears commonly on the east coast in winter, and Sabine's gull an Arctic form that also occurs on the east coast in winter much more commonly than on the west.

A very rare straggler to Cornwall is the Ivory Gull (*Pagophila eburnea*, Phipps), a pure white species with black legs. It, the glaucus gull, and the Iceland gull are the only three gulls that have white primaries, all the rest having these feathers black with white markings. The ivory gull has an Arctic circumpolar range, and very seldom comes as far south as England, though said to be fairly prevalent on north Scottish coasts and in the Orkneys and Shetlands in winter.

Before leaving the subject of gulls mention may be made of their near relatives and arch-enemies the skuas, four species of which may be included in the list of Cornish birds. These are, literally pirates and sea-robbers. They do not fish for themselves, but rob other birds, notably the gulls, of their prey. For this nefarious purpose they are equipped with a sharp hook to the end of their bills and sharp, hooked claws. Ranged according to size the four species are the Great Skua (*Megalestris catarrhactes*, Linn.) a large brown bird with a short tail ; the Pomatorhine Skua (*Stercorarius pomarinus*, Temm.), in which the two central tail feathers are long, broad, and twisted in a peculiar manner ;

Richardson's, or the Arctic Skua (*S. parasiticus*, Linn.), in which the central tail feathers are long and pointed, and which is intermediate in size between the foregoing and next species; and the Long-tailed, or Buffon's Skua (*S. longicaudus*, Vieill.), in which the central tail feathers are very long and slender. There has been an enormous amount of confusion as to the names and identity of the last two species, Gmelin's name *crepidatus* and the name *parasiticus* having been applied indiscriminately to both. In all three members of the genus *Stercorarius* the cap, mantle, back, wings, and tail are dusky brown, the sides and nape of the neck white or cream with a yellowish tinge; the chin, throat, and lower parts white; the sides of the chest in the first two dull brown. None of the four species breed south of the Hebrides, mostly considerably further north, and they are only autumn, winter, or casual, visitors to Cornish waters.

CHAPTER XVII

SOME SHORE-BIRDS

THERE is a sport, very popular with those who cannot afford to rent shooting estates, called shore-shooting, and the quarry in this particular sport consists of shore-birds. The latter term is not, as might be supposed, an ambiguous one including a number of species that happen to inhabit the sea-shore, and that otherwise have no special points of similarity, but refers very definitely to a particular group of closely allied birds, which may be included in the far wider and more embracing term, the waders. In fine, the shore-birds comprise the members of the snipe and sandpiper family, those of the plover family, the turnstones, the oyster-catchers, the stilts and avocets, and the phalaropes, or, respectively, the *Scolopacidæ*, the *Charadriidæ*, the *Arneariidæ*, the *Hæmatopodidæ*, the *Himantopodidæ*, and the *Phalaropodidæ*.

By some authorities the whole of these groups are considered as sub-families of one great family the *Charadiidæ*.

Here, perhaps, an apology, is due to the reader who likes not such long unpronounceable names, but since we are dealing in names and terms, we may as well have the whole lot and be done with it. Long names are sometimes necessary in order to fix definitely the species or group of species under discussion, especially when we are dealing with

birds. More confusion has arisen out of the careless use of names by writers on natural history than can be put right within the next half century, if then, and one of the bugbears of a naturalists' existence is the appalling number of synonyms with which most of our familiar birds, beasts, fishes, and lower organisms are burdened. Let us then be clear and fix definitely in each case the species we are discussing, to do which it is necessary to use its scientific name in conjunction with the popular one chosen at least once. This practice, which has been adopted in these pages, together with the citation of the family name, will serve another purpose. It may be that some amongst my readers will desire to pursue the subjects of our discussion further, and to such these classical names and terms will be of considerable assistance, when they come to look up the literature thereon.

The shore-birds, then, are all waders, having rather long, some very long, legs. Some, such as the snipe, the woodcock, and the oyster-catcher have very long bills ; others, such as the curlews, godwits, stilts and avocets have long necks as well ; while a large number have bills, necks, and legs of medium length. Amongst the last will be found most of the sandpipers and plovers. They occur along stream-beds and river banks, in marshes, on tidal lands and mud-flats at the mouths of rivers, and, during the season, generally spring and autumn, on the sea-beaches and low rocks of the foreshore. Mostly they occur only as transient visitors on our shores and marshes, and so are called birds-of-passage ; but some, such as the common sand pipes, the snipe, the woodcock, some of the plovers, the curlew, the red-necked phalarope, and the oyster-catcher, nest in the British Isles. These,

as well as all the rest of the group, all nest on the ground, many using only a slight depression for the reception of their eggs. Usually four pyriform, or pear-shaped, eggs are laid, their points together in the centre. This uniform number of eggs, and their shape allow of the maximum number being covered and hatched by the brooding bird, since the eggs in all the species are of exceptional size when compared with those of other groups or orders of birds.

It is not intended here to deal with all the shore-birds known to visit or inhabit the coasts of the British Isles ; that were a task entirely beyond the scope of this book. Our object is merely to discuss a few species that were encountered by us in our excursions over the rocks, and along the beaches of the Penzance region and Mounts' Bay during our holiday in Cornwall. It was during the month of August, a time when resident species had completed the rearing of their young, and just before the autumn migrants might be expected. Though the scene of our investigation as regards these birds is laid in Cornwall, it should not be assumed that there is nothing of interest for visitors to the sea-shore elsewhere ; for the same species occur in a good many other localities in our islands ; indeed further north on our coasts they are mostly more abundant, while other species are added to their number.

Since the shore-birds are mainly birds-of-passage, breeding in the far north, and wintering far to the south, it is only natural that there are not many to be classed as breeding in the British Isles, and of these still fewer are likely to be found in the most southerly county : in fact we encountered but four species. These were the Curlew (*Numenius*

arquatus, Linn.), the Turnstone (*Streperus interpres*, Linn.), the Ringed Plover (*Ægialitis hiaticula*, Linn.), and the Common Sandpiper (*Tringa hypoleuca*, Linn.). All four, except, perhaps, the turnstone are admittedly resident in the neighbourhood, and even the turnstone is recorded as being frequently seen in summer in breeding plumage, and is suspected of breeding in the Scilly Isles, if not elsewhere. However, no nest has as yet been discovered anywhere in the British Isles. This introduces us to a very interesting speculative subject. Do the turnstone and other shore-birds, whose known breeding range is far to the north, but which are not infrequently seen in latitudes corresponding with that of Great Britain, actually breed so far south? Some years ago while spending a summer on the north coast of the Gulf of Pe-chi-li, at a place called Pei-Tai Ho in China, whose latitude is about 40° North, that is to say, about ten degrees south of the Lizard in Cornwall, my native assistant shot pairs of several species of waders, such as stints and sandpipers, none of which had ever been recorded as breeding so far south. Without exception these birds were in the breeding plumage, and were apparently mated. My man always brought them in in pairs. He shot them on some sand and mud flats further east along the shore. I visited the place myself with a view to finding out what I could, but since it was already July nesting and young-rearing operations, even if they had been undertaken, must have been completed.

It was too early for the birds to have returned from the north. Two alternative explanations may, it seems to me, be offered. Either the birds of this type that get belated in their northward migration stop at such convenient places as that

under consideration and lay their eggs and rear their young, or else the specimens to be found in such places in summer are more or less immature birds, in which the impulse to continue their journey to more northerly regions, which is apparently brought about by maturity, has not been fully developed. The latter theory does not fit in with the fact that these birds are often in their full breeding plumage, and, all things considered, I am inclined to the view that many of them do breed in these latitudes, or at least make an attempt to do so, and that it is only a matter of time for the fact to be proved by the discovery of their eggs.

As regards the turnstone, it may be stated that we frequently saw this bird in the vicinity of Penzance and Mount's Bay. Throughout our stay in the district, whenever we went down to the rocks at low tide to look for shells, or along the beaches, we were sure to come across a flock of six of these birds that infested the place all the time we were there, that is to say, during the whole of August and the first week in September. What this flock of six birds suggested to me was that they represented a family consisting of the parent birds and four youngsters. I do not know whether it has been definitely observed that the turnstone's family group remains intact after the young have become fully fledged, but the parent birds are said to be very attached to their offsprings. The turnstone lays four eggs, so that the number of the little flock referred to above is compatible with the theory that they represented a family group. If this was so, one might well suppose that the family was hatched and reared somewhere in the vicinity, since the beginning of August, which is when we first saw them, is a bit early for the immature birds

of the far north to appear in a place like Mount's Bay, while had they been migrants, they would hardly have stayed around in one locality for a whole month, as these undoubtedly did.

The fact that no nest or clutch of eggs has ever been found in the British Isles is not of as great importance as might at first be supposed, for it is counterbalanced by the facts that the turnstone's nest is extremely difficult to find, and that it was a long time before any were discovered at all by naturalists.

The first discoverer, a Mr. Hewitson, describes the difficulty he had in locating the first nest, which was ultimately found in a most unlikely site for such birds as waders. "It was placed against the ledge of the rock, and consisted of nothing more than the drooping leaves of the juniper-bush, under a creeping branch of which, the eggs, four in number, were snugly concealed and admirably sheltered from the many storms by which these bleak and exposed rocks are visited, allowing just sufficient room for the bird to cover them." This was on the coast of Norway; but it seems to me that the turnstone may well be a regular, though very limited, breeder in the British Isles, whose nest has hitherto escaped detection by reason of its' rarity and clever concealment.

The flock that we used to watch in Mount's Bay afforded us much entertainment. It was possible to get within a few yards of the birds and to note their behaviour. Especially was this the case when they were feeding upon the weed-covered rocks at low tide. Then they would seem to be too pre-occupied to notice us, and might be seen busily turning over the green weed, *Enteromopha* and *Ulva*,

or sea-lettuce, and capturing the isopods, sand-hoppers, and other small crustaceans that swarm beneath. By inserting their not very long but rather stout bills under the flat stones, and giving a quick, vigorous jerk of the head and body, they would turn them over, or at least push them aside, and so get at the live creatures sheltered under them. Cracks and crannies in the rocks and groins were also examined for food with almost meticulous care.

One point we specially noticed about these birds was the extraordinary way in which they blended with their surroundings. Often when we were within a few yards of the whole flock we could only discern one or two individuals, those that were motionless entirely escaping detection till with a cry they rose up, and on swift wings flew off to a safer distance. They seemed always busy, even when the tide was well up, at which times they might be seen hurrying along the shingles at the water's edge in search of food amongst the debris and wrack of the sea.

Rather thick set and stout of build, the turnstone has somewhat the shape of a plover. It may be described as of a mottled brown above, speckled light upon the head, with black face, fore-neck, and chest, white breast and under parts, a white band over the eye passing down the side of the head, a white spot at the base of the bill, white chin, and a white band on the side of the neck surmounted by a black one. The bill is dark, the legs and feet orange-yellow. The bird utters a distinctly plover-like cry, oft repeated, as it flies low and swift from one part of the beach or rocks to another.

On the sands between Penzance and St. Michael's Mount several flocks of ringed plovers might always

be found. These birds had undoubtedly been breeding somewhere in the vicinity. The ringed plover is probably one of the commonest birds of the foreshore, occurring with equal frequency on shingly beach or sandy flat. It chooses pebbly places, well above high tide mark for its nesting site. There it makes, or chooses, a little depression, lines it with small pebbles and bits of shell, and lays its four eggs, which so exactly resemble their surroundings as to be almost impossible to find. The newly hatched young in their dapple coats of down are equally well harmonized with their surroundings. One further means of safeguarding the precious brood is used by the solicitous parent, and that is the well-known trick of feigning injury, crying piteously the while, and so luring the intruder away from the sacred precincts of the nest. It is remarkable how many birds, belonging to widely different families and orders resort to this strategy. I have noticed it with the Red-legged Partridge, or Chuker (*Caccabis chukor*) in North China, and with the Mandarin Teal (*Anas galericulata*) in the forests of Manchuria.

All the plovers of the genus *Aegialitis* run over the ground in a very characteristic way. Their legs move so rapidly as to seem invisible, and the little hunched up body seems to move rapidly along as though propelled by some unseen agency, the wind for instance. In our species the upper parts are grey-brown, the forehead being banded with two black bars and one white one, the black meeting round the eye and passing backwards to a point. Below this from the chin and throat to the nape is a broad white band, and below this again a black one which broadens considerably on the chest and upper breast. The bill, short,

slender and shapely, is orange at the base, black at the tip : the legs and feet are orange.

When a flock of these plovers is in flight, the birds present a graceful sight, wheeling and turning in unison with the precision of well trained troops. At such times their white under parts flash up and disappear in a bewildering way. We found the birds easy of approach, but far too watchful when we were near them to indulge in feeding as did the turnstones.

The ringed plover is the only member of the genus that breeds commonly along British coasts. The Little Ringed Plover (*Ae dubia*, Scop.), which very closely resembles it, but is smaller, is only a very rare visitor to these islands ; while the Kentish Plover (*Ae. alexandrina*, Linn.), sometimes called *cantiana* of Latham, is restricted in its breeding range to parts of Kent and Sussex, and has been recorded from Cornwall only as a rare casual visitor. This species may easily be distinguished from either of the fore-going by the absence of the strong black bands on head and chest.

With the plovers on the beach in Mount's Bay was usually a pair of common sandpipers, easily distinguished by their smaller size and less hunched appearance. They were less watchful than the plovers, and would busy themselves searching for food till the latter birds took flight. Starting off together, the two species would soon separate, the plovers usually flying further along the beach, the sandpipers flying first out to sea and then generally circling back towards the way we had come. Left alone, however, the two lots would soon be all together again.

Sometimes plovers, sandpipers, and turnstones might be seen peacefully feeding side by side in

one large flock, at times even mixing with the gulls.

The common sandpiper is a dull-plumaged bird, the upper parts being dusky-olive, the feathers with a dark mid-streak and dark margins. The chest and upper breast also are dark, the chin and throat whitish, the lower parts, and outer tail feathers pure white, the latter barred with dusky-olive. There are white edges to the secondary flight feathers. The bill is rather long and brownish in colour, yellowish at the base : the legs dark greenish.

The nest is made in various places on the ground sometimes amongst pebbles, sometimes sheltered beneath bushes. The bird is not purely a coast inhabiting species, but may be found nesting along river banks in secluded places far inland. In Cornwall, where it is known locally as the "summer snipe," our species is recorded as breeding "in sandheaps by abandoned stream works on the moors, and by the side of streams and fresh water pools throughout the county." According to the same account it "leaves its breeding stations in July and August, and slowly makes its way to the coast."

Of the four species of birds mentioned as met by us in Cornwall the curlew was least often seen ; in fact only twice did we definitely note it. Even then we did not succeed in approaching the birds very closely. However, a good many were seen from the train window as we skirted the estuary of the Exe, in Devon, and along the sea coast of Teignmouth.

Nesting on the upland moors of the two counties, Devonshire and Cornwall, curlews are of fairly common occurrence in these parts. The species is recorded as plentiful along the shores in both winter and summer. The presence of the birds

may always be known by the plaintive calls they utter, and from which they have undoubtedly obtained their name.

Rather a large bird, the curlew is unmistakable when seen, its long legs, long neck, and long strongly curved bill at once distinguishing it from all other waders that visit our shores. It is of a general light buff colour, a little darker above than below and covered almost all over with dusky-brown or blackish streaks, occupying the mid-ribs of the feathers. The wing and tail feathers are barred dusky-brown. The bill is brownish : the legs green.

This handsome bird may be seen at low tide wading in the shallow water between low lying rocks, picking its food out of the mass of weed and debris that gathers in such places. In marshes, where perhaps, it is more likely to be seen at certain seasons than on the foreshore, it probes the stagnant slime-filled waters with its long bill, capturing pond snails and other aquatic animals. Like many other shore-birds it feeds greedily upon berries, such as grow abundantly on our moorlands.

During the autumn, winter, and early spring, curlews gather together in flocks of a dozen or so birds, at which times they are eagerly sought after by fowlers, who never lose an opportunity of adding a few brace to their day's bag. When in flocks they are apt to take up the V-shaped formation characteristic of wild-fowl and cranes, though it must be admitted that they do not keep rank very well, and at times break up into disorderly mobs.

The well-known Whimbrel (*Numenius phaeopus*, Linn.) may be called a miniature curlew. It breeds only in the extreme northern parts of our islands, and as regards Cornwall can only be called a passing visitor.

It is almost superfluous to state, that, besides these four typical shore-birds that occur in our region throughout the summer, there are a large number of passing, winter, and casual visitors, nor shall I list them here.

However, the well-known Lapwing, or Crested Plover (*Vanellus vanellus*, Linn.) may be mentioned, since it is recorded as breeding occasionally at Penzance. We did not come across it there, though it was seen while we were on a char-a-banc tour to the Lizard.

The Oyster-catcher (*Hæmatopus ostralegus*, Linn.) is recorded as breeding from the Scilly Isles to Bude and Looe. This handsome bird with its black head and upper parts, snowy white underparts, and crimson-orange bill and legs is a typical frequentor of the foreshore throughout the colder months. In summer it is less common, though it nests in small scattered colonies along the coasts, not far from the sea. The nest is a slight depression lined with various materials, three or four dull yellowish blotched eggs being laid. The food of the oyster-catcher consists mainly of molluscs at extracting which from their shells it is an expert. Crustaceans are also eaten.

CHAPTER XVIII

OTHER BIRDS OF THE CORNISH PENINSULAR

LORD, according to Thy words,
I have considered Thy birds ;
And I find their life good,
And better the better understood :

* * * * *

—George Macdonald.

FEW people are not attracted in some way or other by our feathered friends the birds. Some like them as pets, finding pleasure and comfort in the close company and intimate association that some species will vouchsafe in captivity ; others with a wider sympathy prefer to make their acquaintance in the garden and field ; while many, it is to be feared, care only for the sport derived from their destruction : but to all they are of no little interest.

It is hardly necessary to say, then, that to us, busy though we were collecting and studying other forms of animal life on our holiday in Cornwall, the birds we observed were a special source of interest, especially those species that are not so commonly met with elsewhere, and it is thought that a brief account of the species we saw, may serve a purpose in helping the casual reader, who may be visiting Cornwall during the summer to a greater enjoyment of what he sees while on his rambles through the country.

Several kinds of birds common to these parts, notably marine and aquatic species, have already been dealt with, so that it is only necessary here to discuss a number of land species that are to be met with during the summer.

There are two that inhabit the foreshore that are not aquatic in the true sense of the word, yet which are seldom found far from water. These are the Pied Wagtail (*Motacilla lugubris*, Temm.), and the Rock Pipit (*Anthus petrosus*, Mont.), both well known birds, and very abundant on the shores of Cornwall. The former may easily be recognised by its plumage, in which the forehead and cheeks are white, as well as the breast, lower parts, and outer tail feathers ; the back of the head, mantle, back, chin, throat, chest, wings and inner tail feather are black. In the female the black on the chest is reduced to a narrow band ; while the back and wings are grey. As in all the wagtails, the tail is long, and is kept continually in an up and down motion, which gives these birds their name.

Our species builds a compact well-made nest in a hollow in some stream bank, or in a hole in a wall, other and sometimes very peculiar situations also being chosen. We found this bird very abundant on the beaches round Penzance, where it might be seen catching flies and insects, and searching the tide-wrack for small crustaceans. The pied wagtail is said to remain in these parts during the winter, but by far the majority of the birds of this species follow the example of their relations and migrate to warmer climes. Indeed, the autumn and spring migrations of this bird passing to and from more northerly breeding grounds in these islands form one of the features of Cornish ornithology.

There are few more graceful birds than the wagtails, with their lively ways, rapid movements, and usually striking plumage. The white Wagtail (*M. alba*, Linn.), which is only a spring and autumn visitor to these parts may be distinguished from the pied wagtail by its grey mantle and back. Besides these there are several species in which the lower parts are mostly yellow, and these, too, are very beautiful.

Four species have been recorded from Cornwall, namely, the Grey Wagtail (*M. boarula*, Scop.), the Blue-headed Wagtail (*M. flava*, Linn.), the Yellow Wagtail (*M. raii*, Bonap), and the Ashy-headed Wagtail (*M. cinereicapilla*, Savi.). It is interesting to note that the last species, which is closely related to the blue-headed wagtail, and inhabits southern Europe, has been taken only once in the British Isles, and that was in Cornwall.

The rock-pipit might be described as an insignificant brownish bird frequently to be seen on the shingly beaches and always to be found where great rocks lie jumbled at the bases of cliffs, for the latter kinds of place are its peculiar haunt. It is less streaked than the meadow and tree pipits. The upper parts have a tinge of olive in the brown : the lower parts more buffy, while there is a distinct buffy eyebrow. The breast and flanks are obscurely spotted and streaked respectively. The rock-pipit builds its nest in a hole or cranny in some rock not very far above high-water mark.

We frequently come across this bird along the Cornish coast, where it and the pied wagtail might be seen quarrelling, the latter bird apparently the aggressor. The pipits, wagtails, forming one might almost say, a connecting link between the latter and the larks. They show the same long claw on

the hind toe that characterizes these two groups.

A bird that is fairly common in the fields and upon the downs is the Sky Lark (*Alauda arvensis*, Linn.), while the Wood-Lark (*Lulula arborea*, Linn.) is also a common Cornish resident though probably not often recognized. Of these the sky lark is the larger bird and occurs more in open places, the wood-lark being more an inhabitant of wooded or bushy parts, where it builds its nest upon the ground. Its habit of singing from a branch rather than indulging in the characteristic song-flight of the sky lark further distinguishes it from the latter, of whom Tennyson wrote :

"The lark could scarce get out his notes for joy ;
But shook his song together as he neared
His happy home the ground."

If there is one bird more than any other associated by name and tradition with the county of Cornwall it is the Chough (*Pyrrhocorax pyrrhocorax*, Linn.). Indeed, to most people it is known as the Cornish chough. For many centuries it has been known as an inhabitant of the cliffs and crags of the Cornish coast, and was, apparently, fairly common up to the beginning of the nineteenth century. During the last hundred years, however, its numbers have been steadily diminishing, till now it can be considered only as a rare bird.

In 1905 it was recorded in the "*Victoria History of Cornwall*" as breeding on the north coast only east of Mawgan Porth, in which year also twelve nests were reported between Newquay and Hennaciff. Whether any birds breed now on the south coast does not seem certain, but judging from the same account it would appear not. The report says it was recorded as nesting "at Turbot Point to the south of Mevagissey, till after 1820, at Kynance

and Mullion till about 1832, at Tol-pedn-penwith, near the Logan stone, till about 1849, and a nest was found at Trewavas Head in 1854." This does not bring us very near to our own times, and we find ourselves contemplating the melancholy fact that the chough is threatened with extinction in Cornwall.

There is a record of a specimen having been shot in the Scilly Isles in the winter of 1899, which show that the bird, though described as sedentary, and seldom venturing far from its nesting haunt, does at times wander fairly far afield.

While on the way to Kynance Cove from Penzance during our stay in the latter district, I saw two birds on the high land to the east of Kynance which I strongly suspect—though I cannot absolutely assert the fact—of being a pair of choughs. They were flying about in the very characteristic manner of the species, and at times alighting on the low walls that divide the fields in these parts, but they were too far away for the colour of their bills and legs to be made out. But for their flight being that of the chough, with which I am thoroughly familiar, I should be extremely hesitant about suggesting the presence of this species in this district at such a time of year, August. As it is, and if my identification of the birds is correct, it makes an extremely interesting record, and might be taken to suggest that the chough is increasing its breeding range in the county once more. There is just a faint hope that such may be the case contained in the report in the "*Victoria History*" already referred to, which says, "In 1901 only seven nests could be found as a result of a careful survey of the coast between Newquay and Hennaciff. A less thorough examination in 1904 showed the presence of ten nests, and this year (1905) twelve have been recorded."

According to Mr. T. A. Coward, in his recent book on British birds and their eggs, it is not altogether the fault of egg-collectors that the chough is going under, but that "competition with, rather than the antagonism of, the increasing pushful Jackdaw, its frequent companion has much to do with its decrease;" Another older source of information, lays the blame on the peregrine falcon, which is said to be particularly fond of the flesh of the chough. Either or both of these causes may be operating at the present time, but undoubtedly the gravest crime against this beautiful bird has been that committed by the egg-collectors in so far reducing its numbers as to render its struggle against the aggressive jackdaw or the marauding peregrine ineffectual.

There are a great many instances of a similar nature in connection with birds and animals that are becoming, or have become, extinct in recent years. These species, it would seem, were able to hold their own in their chosen habitats, maintaining a state of equilibrium in regard to numbers, until man came along and by some means, accidental or intentional, turned the scales against them, upsetting the nice balance which nature had maintained, who can say how many hundreds or thousands of years. Subsequently all efforts to restore the species to its original abundance, or even to keep them from extinction, failed. There seems to be some law which comes into action here, though as it has neither been formulated nor proved, to the effect that once a given species has had its numbers reduced below a certain point, it is doomed to extinction. It might also be suggested that in each species there is a definite number of individuals required to maintain a certain amount of cross-fertilization in

order to keep it in a sufficiently virile condition to withstand the ravages of its enemies. Or it may be merely a matter of arithmetic as, say :—if ten peregrines each kill one chough a week and each pair of choughs raises four young a year then it requires 125 pairs of choughs to help up the supply as well as the original stock ; and that, if that stock be reduced to one hundred, all other things being constant, extermination of the whole race must follow in a comparatively short time.

Whether the point in numbers, from which no recovery is possible, has been reached by the chough in Cornwall remains to be seen.

A closely related species, the *Pyrrhocorax brachypterus* of Swinhoe, which some authorities consider to be identical with the European and British bird, is extremely common in the mountainous and hilly regions of North China, and there it associates with the two local species of jackdaw in immense flocks during the winter months, nesting and breeding side by side with them in the spring and summer. There appears to be no danger of its extinction, though the jackdaws outnumber it by dozens to one.

The Cornish chough may be described briefly as a bird intermediate in size between the jackdaw and the rook, with much the build and appearance of the latter. Its glossy black plumage has a beautiful purplish sheen on the body, blue-green on the wings. Its bill is slender and gracefully curved, and with the legs and feet are of a fine orange-red colour. Its wings are unusually long and broad, and the bird is extraordinarily nimble in the air, carrying out all kinds of graceful evolutions, at the same time uttering its characteristic call.

Essentially a bird of the crags, the chough makes its nest in crevices in the most inaccessible cliffs or

in the roofs of high caves, where it raises its brood of four to six young. These may be seen fully fledged with their parents in July, flying about in small family parties. Whether the birds assemble together in large flocks in Cornwall, as they do in Asia, would appear doubtful owing to their lack of numbers.

With their lively ways and graceful movements in the air choughs are charming birds to watch, and it is to be hoped that by careful protection and the forbearance of egg-collectors the species may be assisted in regaining its former position in the ornithology of Cornwall.

Probably the most characteristic bird of the headlands and downs of the Cornish Peninsular is the Wheatear (*Oenanthe oenanthe*, Linn.) a summer visitor that breeds regularly and plentifully in the district. It is thought that some birds may spend the winter in Cornwall. We noticed numerous individuals at both the Land's End and the Lizard in August. As a passing migrant the species is said to be extremely abundant in the county and in the Scilly Isles. When also its near relative the larger and more brightly coloured Greenland Wheatear (*O. æ. leucorrhoa*, Gm.) may be seen. Our bird is at once recognizable on account of its conspicuous black and white tail, which it is always flirting and displaying. The upper parts are greyish, the throat, breast, and lower parts creamy white tinged on the breast with sandy-buff. The forehead, eyebrows, rump, upper and lower tail covers, and basal part of the outer tail feathers are white, the two middle tail-feathers, and the terminal parts of the other being black. A black band extends from the base of the bill across the eye and side of the head. The wings are dusty or black, the feathers mostly light

edged : the bill and legs are black, the latter being rather long. The tail is short and square. The bird is altogether of graceful appearance and movements, well repaying observation, as it flits from spot to spot, darts into the air after insects, runs swiftly over the level ground, bobbing its head and body and flirting its tail and wings. Its note, which may be rendered *chat, chat, chat*, is repeated incessantly, sometimes being varied by a short, sweet song uttered as the bird flies up into the air.

The wheatear makes its nest in rabbit burrows, even those in use by the rodents, where it builds a loosely knit affair, lined with fur and wool, at a short distance within the mouth. Five or six young are reared, the eggs being of a pale blue without markings.

A bird that is closely related to the wheatear and is listed as a resident species in Cornwall, breeding and wintering in the county, is the Stonechat (*Saxicola rubicola*, Linn.). It may be seen during the summer flitting about over the gorse and bracken of the downs, and is at once recognizable by its black face, cheeks and throat, reddy-buff breast, brown, dark-speckled upper parts, and conspicuous white patch on each wing, white patch on the rump, and white edges to the black cheeks. The female is without the black of the cheeks and throat and the white of the wings, rump, and side of the neck, being speckled brown above and reddy-buff below. The stonechat should not be confused with the Whinchat (*S. rupetra*, Linn.), which also occurs in the county in both summer and winter but is not nearly as common. In this species the throat is white, there are white eyebrows, no white on the rump, but the basal parts of the side tail feathers are white, the terminal parts and the two middle

feathers black, while the whole bird is lighter and less richly coloured.

Both the stonechat and the whinchat are smaller birds than the wheatear, and are more bush or scrub inhabitating species. The nest of the stonechat is built near the ground in or under the gorse bushes, and consists of roots, grass, moss, wool, and a lining of hair and feathers ; that of the whinchat on the ground in dense brush or even in thick grass in the open, and of much the same materials.

We noticed the stonechat in fair numbers on the downs and in the rift above Kynance Cove in the Lizard, and also came across it in the vicinity of Penzance. It might be seen in what were, apparently, family parties of five or six playing about in the bushes, or perched on outstanding sprigs, whence each bird made continual darts into the air after passing insects.

The name of this species is undoubtedly derived from its oft-repeated note, which sounds exactly like two stones being knocked together.

There are some interesting records of the occurrence of North American birds and species from other foreign parts in Cornwall, so, for instance, that of the Red-winged Starling, or Blackbird (*Agelæus phæniceus*, Vieillot) a specimen of which was shot at Swanpool, Falmouth, in August, 1881. Whether the occurrence of such a bird is due to the escape of a caged specimen, or to its having been driven out of its normal course in migration by some agency such as adverse winds is a moot point ; but there are records of so many North American birds in our islands, many of which would not be likely cage birds, that it seems going out of one's way to explain their appearance by supposing them to be escapes from captivity.

Of another bird, the American Little Green Heron (*Butorides virescens*, Linn.), the only recorded straggler to the British Isles was shot at St. Austell, in Cornwall, in 1889.

The Glossy Ibis (*Plegadis falcinellus*, Linn.) is listed in the "*Victoria History*" as "an occasional accidental autumn wanderer to the west of the county." It is all the more interesting then that this year (1920) a flock of ten birds visited the vicinity of St. Michael's Mount and Marazion, where in the marshes they were observed, studied, and even photographed by Mr. A. W. Boyd, whose account appeared in the November number of "*British Birds*." These birds were first observed on September 19th, but some were still seen on October 1st. As it happens the same number of "*British Birds*" records another bird of this species from the Ere estuary on September 23rd, the same or another in the same locality on the 24th, and yet another was shot near Ross-on-Wye in Herefordshire on September 2nd. The season, it would seem, was a good one for the species.

On the whole the glossy ibis appears to enjoy rather a wide distribution, but the cause of its visits to our shores has not yet been ascertained, or more than tentative explanations offered. The difficulty in regard to its appearance lies in the fact that its breeding range is southern Europe, and its winter haunts further south, so that the birds that we see should seem to have wandered very far out of their way. Mr. T. A. Coward suggests in his book already referred to, that as so many of the birds shot in the British Isles are immature, their occurrence represents an irruption from their regular haunts in an attempt to increase their range. This seems a very

reasonable explanation, especially as we know irruptions of such a nature do occur in the animal world. In this respect, and speaking of bird irruptions, what are probably the most famous instances in the annals of ornithology, the two invasions of our islands by a Central Asian bird, Pallas' Sand-Grōuse (*Syrrhaptes paradoxus*, Pall.), supplied Cornwall with a number of records of the species in both the years 1863 and 1888. Doubtless also birds reached the county in the last invasion in 1908 but I do not know of any records. "In 1888 a flock of eleven appeared in the Land's End district, of which three were killed and one captured alive," says the "*Victoria History*," which also records several birds being shot in other places.

In the winter of 1907-08, I was at Tientsin, in North China, and well remember that the sand-grouse appeared in that district, as well as throughout the province of Chihli, in enormous numbers. The game markets were full of birds alive and dead, while local European sportsmen enjoyed some very fine shooting. This would be the same irruption that supplied the British Isles with their birds in the spring of 1908. Now when the sand-grouse appear in large numbers in North China it is usually because of severe weather, much snow and so on, but on this particular occasion they came down from the Gobi in such swarms that it was obvious that some other agency was at work.

There is a disintegrating force in Nature, which, when colonies of living organisms get beyond a certain numerical strength, causes the individuals, or even groups of individuals to break away from the parent colony and to scatter. Hence such irruptions as those of the sand-grouse, and as suggested of the glossy ibis. Doubtless in each case

there is a steady increase in the numbers of individuals reached, and then the great scattering takes place. The disruptive force, whatever it may be, may be observed working in many branches of animal life—the swarming of bees and ants, the migrations of locusts, the great trek of the banded lemming, for example—man himself included, as witness the numerous irruptions of the Mongols from Central Asia during the Middle Ages and even in more recent times.

Undoubtedly Nature uses this force as a means of spreading the various successful species, birds included, over the face of the earth ; and if they discover suitable regions wherein they may settle, so much the better. If not, they perish, leaving room in their original habitats for a further increase, and a possibility of repeating the experiment at a later date, perhaps with better success.

Many other interesting birds have been recorded from Cornwall as stragglers and casual winter or summer visitors, such, for instance, as the Great Bustard (*Otis tarda*, Linn.) and the Little Bustard (*O. tetrax*, Linn.), the former being somewhat the rarer, but it is not intended here to mention any others, for after all they cannot be considered as typically Cornish. Those who wish to know more on the subject may be referred to the many excellent works on British ornithology, some of which mention most of the known records of such rare visitors.

CHAPTER XIX

ROCK-FISHES AND OTHERS

NO nature student worthy of the name who pays a visit to the sea-shore, can fail to have his interest aroused by the various species of inshore fishes that must inevitably come under his notice, and of these the rock-inhabiting forms will doubtless make the keenest appeal.

To begin with they present such extraordinary and varied shapes, their colours are so vivid, that in themselves they are creatures that must awaken one's sense of the marvellous. Then, again, their wonderful homes, the intricate rocks that they inhabit, the sea-gardens, the rock-pools with all their varied animal and vegetable life, the deep chasms and submarine caverns, where deadly enemies lurk—these must find response in the romantic sides of our nature; for are not the lives of the denizens of such a world true romances? However much we may recoil from "Nature red in tooth and claw," or dislike the law of "Eat and be eaten," we cannot deny that the game of life as played by the more intelligent of these living organisms, such, for instance, as the little blenny of our rocky shores, commands our attention and holds our interest the moment we begin to investigate it, even in the most cursory manner. We note how wonderfully Nature has adapted each of the multifarious forms of animal life to play its part; how each fits its

niche in the general scheme of things. We see with what deadly swiftness indiscretion, or a departure from the rules that govern the animate world is followed with punishment, usually extermination ; yet, if we look more closely we see a tendency on the part of many organisms to be ever experimenting, ever essaying some new refinement of development. In this game death and extinction are the price to be paid for mistakes or failures, life and greater security the reward of success.

Most marine animals show such a tendency, and of them all the finny inhabitants of the rocky parts of the coast, with their many subterfuges, and complex lives, show it the best. It may be said of many of them, such as the gobies, cottids, and blennoids, that they are in an unstable condition, a plastic state, so to speak, and that could we but watch them for a sufficiently long period, we would find that instead of being fixed and highly specialised forms, incapable of any very great change, they are even now in an active state of evolution. Take, for example, the case of the blenny. What possibilities do not lie in the habit it has acquired of leaving its proper element, the water, and basking in the sun on some ledge of rock ? Living, as it does, where air, land and water meet, always from the very earliest times the most fecund spot on the earth's surface, and productive of the greatest number of new forms and species, and with such a habit already acquired, the blenny may develop into anything. It may be the prototype, the first primitive ancestor of a whole world of new vertebrate land animals !

It must have been in just some such way that the early amphibians arose, and filled for a time the swamps of the Carboniferous age with their great

and hideous forms ; that the lizards, the gigantic dynosaurs and others of the Jurassic period, had their beginnings ; and that from some lowly forms in that age of monsters, some quite simple and insignificant reptiles, our present day mammals and birds arose. What prophetic intelligence could have foretold "man" from an examination of those primitive creatures crawling out of the slime of the ocean to life and breath in the light of the sun ? Yet potentially man was there.

It is true the blenny belongs to what may be called the most modified group of fishes, the *Acanthopterygii*, in which the thoracic position of the ventral fins, or pelvic limbs, show a great advance on the primitive fish type, wherein these limbs are far back in the body ; but, though this limb modification effectively precludes the possibility of the blenny ever developing into an animal with the locomotary organization of the present day quadrupeds, it does not preclude the possibility of the development of some other methods of terrestrial locomotion. Here we may pick up a suggestion from watching the gurnard, another of the acanthopterygious fishes, closely related to the cottids, in which three rays of each pectoral fin have separated from the others, and are in the form of tactile appendages used by the fish as legs in its progress across the sea-bottom. Another gurnard has enormously developed pectoral fins, suggesting wings. Many other instances of peculiar modification amongst the members of this group of fishes might be mentioned showing that, though in some ways they are specialized types, yet that that specialization is in progress at the present time, nor does it appear to have gone so far in any given direction—such as the development of the wing in the bird, or the single hoof in the

horse—as to preclude development in any other.

The reader will see, then, what unusual interest attaches to the rock-fishes of our coasts, since they may start in one's mind such trains of thought as these ; and so, without further apology or explanation on the part of the writer for his choice of subject, we may proceed with an examination of these forms of marine life.

In the course of our investigation in the Penzance district of Cornwall, we found a number of rock-fishes, and it is with those that we actually saw or collected it is intended to deal here, though, of course, some mention will be made of other members of the families or genera to which they belong.

Perhaps the most interesting of these fishes, and certainly those that come first under one's notice, are the denizens of the rock-pools. These, it will be found, mostly belong to more or less closely related families of the sub-order *Acanthopterygii*, in which the fins are spiny-rayed, and the ventral, or pelvic fins are situated very far forward, or, to use the correct phraseology, are thoracic in position. To this group belong the gobies, the blennies, the cottids and the cling-fishes, or suckers. The wrasses also belong to it, but are not as a rule to be found in the rock-pools, unless these are very large and deep.

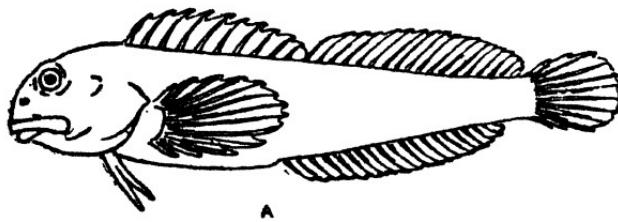
Another rock-pool fish is the little worm pipe-fish, belonging to the sub-order *Catostomi*, which further includes the well-known sticklebacks, and the quaint little Sea-horse (*Hippocampus*). In these the ventral fins, when present, are not so far forward as in the foregoing.

The rocklings, belonging to the sub-order *Anacanthini*, in which the ventrals are far forward, but the fins have no spiny rays, are also to be found in rock-pools, and occasionally the common eel as well ;

though its near relative, the conger, keeps to the rocks below the tide. These two species belong to the sub-order *Anguilliformes*, or *Apodes*, distinguished by the complete absence of ventral fins.

Altogether some ten species may be included in our list of rock-inhabiting fish. Of course, there are many more than this to be found, but these ten which are given below, were definitely located by us in the district under discussion.

Probably the commonest fish of the Cornish rock-pools is the Smooth Blenny, or Shanny (*Blennius*



A.—Shanny (*Blennius pholis*, Linn.).

pholis, Linn.). Indeed, it is fairly common in such places all round our coasts. It belongs to the family *Blenniidæ*, in which the head and body are soft-skinned, scaleless, and without spines ; the eyes are set high in the head ; the spinous and soft-rayed dorsal fins are usually continuous, though interrupted or divided in some species, and occupy practically the whole of the back and tail ; the ventral fins are reduced to two soft rays, sometimes one, and are set so far forward as to be in front of the pectorals ; the pectorals are large and rounded ; the caudal fin rounded, truncate, or wedge-shaped ; and the head frequently adorned with peculiar fleshy plumules. In our species the head is unadorned with any fleshy appendage, a fact which at once distinguished it from other species of similar shape and proportions.

Of a dull olive-grey colour, it is marked on the sides with six irregular and more or less broken bands of darker colour, and is rather closely spotted on the fins. The head is dark, with irregular specklings of the same light ground colour as the body. The fins are as described for the family, being interrupted but not completely divided between the two dorsals.

The shanny shows distinctly thickened lips, while its jaws are armed with sharp teeth. It attains a length of about five inches, though most of the specimens to be encountered are considerably less.

The species keeps strictly to the bottoms of the pools, as it does not possess a swim-bladder. When undisturbed it moves about over the rocks in a very stealthy manner, never venturing very far from some sheltering cranny. Not infrequently it is left behind by the tide sheltering beneath a stone or in a rock crevice where no pool exists. The absence of water does not occasion it any inconvenience, in fact, the fish actually leaves the water, and by a dexterous use of its pectoral fins and a wriggling motion of the body, takes up a position upon some ledge or even out in the sun upon some exposed rock surface. If disturbed, it immediately drops back into the water.

Its food consists of any mollusc, crustacean or other living organism sufficiently small for it to take into its mouth. Its eggs are laid in the summer, and for the short period before they hatch out, are guarded by the parent, who will fearlessly and with great fury attack any intruder.

Other blennies that occur on the Cornish coast are:—Montague's Blenny (*B. galerita*, Linn.), occasionally found in rock-pools, and at once distinguishable by its prettily coloured and variegated body

markings, and head plumule ; the Tompot (*B. gattorugine*, Bloch.), with two head plumules, and of a deep red-brown, or purplish, colour ; and the Butterfly Blenny (*B. ocellaris*, Linn.), with two simple head plumules, red-brown colour, and very high dorsal fins, the anterior of which has a large ovate dark brown spot. Both the tompot and butterfly blenny keep more to deep water in the close vicinity of rocks, and may be caught by hook and line. Indeed, the tompot is sometimes a great nuisance to anglers, since it swallows the hook right down, thus necessitating a disgusting surgical operation to recover it.

The elongate Gunnel, or Butterfish (*Centronotus gunnellus*, Bloch.), is also said to be common between tide marks in Cornwall, though we did not come across it at Penzance or in Mount's Bay. This blenny differs from any of the foregoing by its very long, eel-shaped body and long, low, and complete dorsal and anal fins. Its length is about six inches.

The Long-spined Cottus, or Father-lasher (*Cottus bubalus*, Euph.) is fairly common on the Cornish coast, as well as all round the shores of Great Britain. As it keeps to the rocky parts well up with the tide, it is frequently left behind in the rock-pools, where it lurks under weeds. The *Cottidae*, to which family this fish belongs, are characterized by their large, rather depressed or flattened, heads, usually armed with sharp spines at the posterior and ventral angles of the gill-plates ; tapering bodies ; divided dorsal fins ; large pectorals ; and much reduced ventrals, situated well forward, level, or just behind the pectorals. The little Bullhead, or Miller's Thumb (*Cottus gobio*, Linn.) of our streams and rivers is the typical British fresh-water representative of the

family, which with the Pogges (*Agonidae*), the Gurnards (*Triglidae*), the Norway Haddock and its congeners (*Scorpaenidae*), and several other families, are included in a series called the *Scleroparei*, or mail cheeked fishes.

The cottids have a northerly distribution being particularly abundant in the North Pacific and the cold Okhotsk Sea ; while two closely related families belong exclusively to Lake Baikal in Siberia, being represented by a number of more or less bullhead-like species.

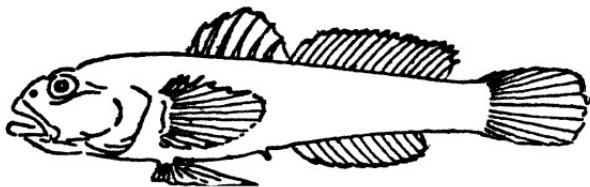
The father-lasher may be recognized by its close-set eyes, and the long, sharp wicked-looking spines on its head and at the angle of each gill-plate. These it protrudes when disturbed by distending the gill-plates. This fish is of a dark brownish, purplish or reddish-brown colour above, mottled irregularly with yellowish or even white ; light on the under surface. Sometimes the pectoral fins are barred red, and the whole fish is more intensely coloured than usual. Though it attains a length of some ten inches, only specimens of two or three inches in length are to be found in rock-pools. The larger specimens may be taken with hook and line though care should be exercised in handling them, as they are quick to inflict wounds that smart.

For spawning purposes this fish leaves the rocks and frequents river estuaries, and neighbouring sandy or muddy shoals, where it deposits its large, orange-coloured eggs.

A closely related and somewhat similar species both in habits and appearance is the Short-spined Cottus, or Sea Scorpion, (*Cottus scorpius*, Bloch.). This may be recognized by its shorter gill-plate, or opercular, spines. It is far less common on the Cornish coast than the father-lasher, a name, by the

way, that seems to be freely used for both species.

Two species of goby were secured by us in the rock-pools round Penzance. These were Willoughby's Goby (*Gobius paganellus*, Gm.), and the smaller



B.—Goby (*Gobius paganellus*, Gm.).

Two-spotted Goby (*G. ruthensparri*, Euphr.). The gobies belong to the family *Gobiidae*, and are characterized by the modification of the ventral fins into a sort of saucer-shaped, though distinctly rayed, sucker on the under surface of the body, level with the base of the pectorals. The dorsal fins are divided, and not very high, the anterior one being the shorter. The caudal fin is truncate or rounded. The head is wide, depressed, with swollen cheeks. The mouth is wide, terminal, has thick lips ; and the jaws are armed with teeth. There are no spines on the gill-plates, but the body is covered with easily discernable scales.

The gobies are essentially inshore, estuarine, or rock-pool inhabiting fish, indeed *Gobius paganellus*, is almost as common in the pools round Penzance as the shanny, frequently the same pools, and often found under the same stones. About three inches in length, with a cylindrical and slowly tapering body, and slightly compressed tail, this species is of a dusky-olive colour, mottled on the cheeks and sides with a lighter shade. It is closely related to the Rock Goby (*G. niger*, Linn.), which is more of a shoal or estuary inhabiting species, and is recorded as common in Cornwall. A large and somewhat familiar form,

recorded by Couch as *G. niger*, measuring up to ten inches is referred now to Cuvier and Valencienne's Giant Goby (*G. capito*). The gobies lay rather small, drop-shaped eggs, which they attach by the thin end to some rock, or on the inside of an empty bivalve shell.

The little Two-spotted Goby also appeared to be rather common in the rock-pools round Penzance, at least, several specimens taken by us of small fish swimming about in the higher and smaller pools all turned out to be referable to this species. It is under two inches in length, to judge from our specimens, and is more slender, with a less depressed, or flattened head than in *paganellus*, the eyes being proportionately larger. Of a brownish colour, it is at once distinguishable by the two round dark spots on the side, one just behind the pectoral fin, the other at the base of the caudal fin. The species may be watched swimming about in and out of the slowly waving weeds that line the sides of the pools it inhabits.

Other species of goby recorded from Cornish coastal waters are, the Freckled Goby (*G. minutus*, Linn.), said to be common in estuaries on the north coast ; the Painted Goby (*G. pictus*, Malm.), abundant on the south coast, but not seen by us ; the diminutive *G. scorpioides*, of Collett, secured in Falmouth Harbour ; the Transparent Goby (*Aphia pellucida*, Nardo) ; and the Crystal Goby (*Crystallogobius milsonii*, Dub. and Kor.).

A group of fishes, which are related to the blennies and so come into the series *Jugulares*, the position of the pelvic or ventral fins being so far forward as to be jugular, are the cling-fishes or suckers of the family *Gobiesocidæ*. These are mostly tropical or sub-tropical in distribution, but three members of

the genus *Lepidogaster* occur on British coasts. Of these we found one, the Cornish Sucker (*L. gouanii*, Lacép), very common in the region of Penzance. This is a small fish in which the ventral fins are



c.—Cornish Sucker (*Lepidogaster gouanii*, Lacép.).

modified into a sucker, or suctorial disc, on the ventral surface, which is rather peculiar in that it is divided into two portions, one anterior horse-shoe shaped, the other behind it and cup-shaped. The pectoral fins are small and to the side just above the middle of the sucker as a whole. The whole of the under surface of the head and anterior part of the body are flat, so that the little fish can press itself against the flat surface of a stone or rock, where, with the aid of its sucker, it sticks like a leech. The head is wide and flat, the eyes being prominent, and the snout tapering and blunt. In effect, it reminds one strongly of the head of a small dog or weasel. There are two peculiar little plumules just in front of each eye, the anterior one about twice the length of the posterior one. The body is cylindrical, anteriorly compressed and tapering posteriorly. The dorsal and anal fins are situated far back, and are joined by a membrane to the rounded caudal. The colour of this interesting little fish is of a deep reddish-brown, with a pair of ocellated spots on the top of the head back of the eyes. Some of the specimens secured by us were light pinkish, or flesh-coloured; but these soon turned dark. It was noted that while in captivity our specimens changed colours repeatedly, varying between the light pinkish to almost black. They might thus

closely imitate the various colours of the red and brown seaweeds amongst which they lived. The largest of our specimens was not more than 2½-inches in length. We found these little fishes very numerous under stones and in weed-filled pools well down on the rocks a little above low-water mark.

Two other members of the same genus have been recorded from Cornwall, namely, the Double-spotted Sucker (*L. bimaculatus*, Flem.) and the Connemara Sucker (*L. decandolii*), the latter being of very rare, if not altogether doubtful, occurrence.

Amongst the members of the family *Labridæ*, or wrasses, will be found some of the most beautifully coloured fish of our coasts. A well known example is the Ballan Wrasse (*Labrus maculatus*, Linn.) whose vivid blues, greens, reds and orange, vary in proportion and position in different individuals. All the wrasses are rock inhabiting species ; and some seven forms are recorded from the Cornish coast, mostly as common. We did not secure any specimens from rock-pools, though we frequently caught members of one, possibly of two, species while pollack-fishing off the pier at Penzance. Specimens preserved have been identified as belonging to the species *Crenilabrus melops*, Linn., which is known in most places as the Connor.

Shaped something like a perch or bass, the wrasses have the dorsal fin long and not divided, the anal fin fairly long, and the caudal rounded or truncate. The head is pointed, the mouth small, with numerous sharp teeth, and lips that can be turned back, exposing the gums in a most unusual way. The ventral fins are not so far forward as in most acanthopterygious fishes. The anterior gill-plate, or preoperculum, is serrated on the posterior and ventral edges. In our species, which attains a length

of some six or seven inches, perhaps a little more, the head is blue, or blue-green, with brilliant orange-red lines, while the body is greenish spotted with the same bright colour, the green fins being barred with it.

Once or twice we caught larger specimens of a uniform olive-brown colour, but these have not been identified, and might have been females of some of the large species.

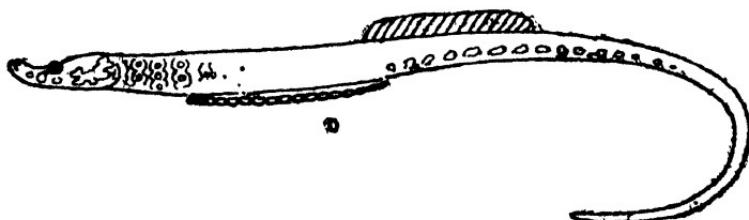
Other species of wrasse recorded as occurring in Cornish waters are the Cook, or Cuckoo' Wrasse (*Labrus mixtus*, Linn.), which is red with blue stripes ; Jago's Goldsinny (*Ctenolabrus rupestris*, Linn.), orange with the edges of the scale golden yellow, the anterior portion of the dorsal fin black, a black spot on the dorsal base of the caudal, and the side broadly but slightly barred ; the Scale-rayed Wrasse (*Acantholabrus palloni*, Risso), a large, more slender, light-brown species with yellow-edged fins, not very common ; the Rock Cook (*Centrolabrus exoletus*, Linn.) rather deep in the body and of a brown colour, darker above than below ; and the Rainbow Wrasse (*Corus julis*, Linn.), possibly the most beautiful of all, with its greenish-blue back and broad longitudinal band of orange down the side, below which are further bands of mauve and silver, its dorsal fin of orange, marked anteriorly with a large purple spot, and its broadly-barred caudal fin. There appears to be but one record of this last species, which really belongs to the Mediterranean, a specimen having been taken in Mount's Bay in the summer of 1802.

There should be no mistaking a pipe-fish when seen. The long, slender body and peculiar tubular jaws, with the small up-turned mouth at the end, are characteristic. The pipe-fishes belong to the

family *Syngathidæ*, of the series *Lophobranchii*, which is related to that containing the stickle-backs, and contains also the little sea-horses. Probably the most interesting feature about the pipe-fishes and sea-horses is that the males act as nurses for the eggs and young, possessing, as they do, brood-pouches, into which the spawn is transferred from the female.

It is rather a remarkable fact that in most of the members of the sub-order *Catostomi*, the paternal instinct is highly developed. Amongst the stickle-backs it is the male that builds the nest, into which the females drop their eggs, leaving them to his care, and well does the gallant little fellow guard his treasure. Even when the eggs are hatched he watches the larval young, and if they stray from the nest pursues and seizes them in his mouth and returns them to the paternal nursery. The male sea-horse has a marsupial pouch or sack, wherein the eggs are hatched and the young remain for some time; while the male pipe-fish has a long hollow, or groove, into which the eggs fit, and where they remain till hatched.

Pipe-fishes, like the sea-horses, frequent the vicinity of rocks, where they are not easy to distinguish from the slender fronds of some of the weeds. In the vicinity of Penzance, in the pools amongst the rocks, and under stones, from a little above low-water mark seawards, the so-called Worm



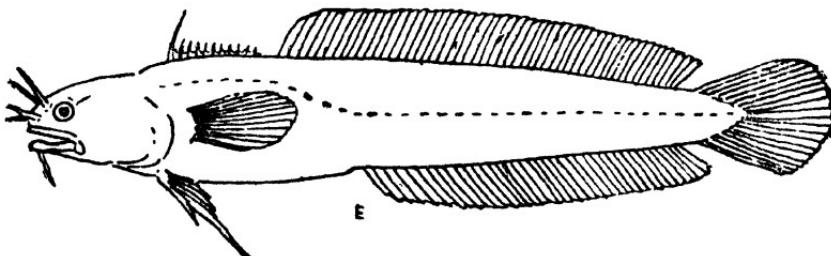
D.—Worm Pipe-fish (*Nerophis lumbriciformis*, Yarrell.)

Pipe-fish (*Nerophis lumbriciformis*, Yarrell) is extremely common, and we obtained a number of specimens of both sexes. The males had their brood-pouches full of nearly ripe eggs. In this species, which attains a length of about six inches, there is only a short dorsal fin, no other fins being present in the adult. In the very young, however, pectorals are present, as well as a continuous membrane round the tail. The snout is short and bent slightly upwards. The colour of this peculiar little fish is dark red-brown, sometimes olive-green, the head and fore part of the body, as well as the lower part of the tail, peculiarly barred with light, irregular markings. Though plated, the body is much more smooth than in other pipe-fishes, the plates being indiscernable, except on a close inspection.

Other species which have been recorded from Cornwall are the Broad-nosed Pipe-fish (*Siphonostoma typhle*, Linn.), reaching a length of over a foot, having a broad and deep tubular snout, pectoral and caudal fins, the body plated and hexagonal in section, and said to be common in the beds of *Zostera*, or sea-grass ; the Greater Pipe-fish (*Syngathus acus*, Linn.), similar but larger, up to two feet in length, with a more slender snout, and common in the beds of *Fucus*, or wrack ; the closely related but smaller *Syngathus rostellatus* of Nilsson ; the Snake Pipe-fish (*Nerophis aequoreus*, Linn.) ; and the Straight-nosed Pipe-fish (*N. ophidion*, Linn.), the last two, like the worm pipe-fish, having no pectoral or caudal fins, and the last being very long and slender.

Very different from the pipe-fishes are the rocklings, our next group. These belong to the great cod family, *Gadidæ*, and are characterized by their slender, somewhat eel-like bodies, and their long

posterior dorsal and anal fins, rounded caudals, and barbed decked snouts and chins. At first sight they might be taken to be related in some way to the blennies, but a closer examination soon reveals their affinities with such forms as the fresh-water Burbot (*Lota lota*, Linn.) and one must suppose that they and some of the blennoids and other unrelated fishes have come to have a somewhat similar external form through occupying a similar environment. As the name suggests they are essentially rock-inhabiting fish, one species, the Five-bearded Rockling (*Motella mustela*, Linn.) being extremely common in rock-pools, under stones, or hiding beneath the dense masses of seaweed at low tide. This species, many specimens of which we



E.—Five-bearded Rockling (*Motella mustela*, Linn.).

took, is of a rich red-brown, or maroon, colour all over except on the under surface of the head and abdomen, where it is pale flesh-colour. It is at once recognizable by its five barbels, four on the snout, and one on the chin. Its body is covered with small, but distinct scales. The anterior dorsal fin is very low, except for the first ray, and lies in a sort of narrow pit just back of the head. In a newly captured specimen this fin may be seen to vibrate in a peculiar way. The body is compressed posteriorly, the head flattened or depressed, the mouth wide, and the snout rounded. The eyes are not

very large. The fish attains a length of ten inches, seldom more.

The Three-Bearded Rockling (*M. tricirrata*, Bl.) the adult of which keeps more to deep water is common round the Cornish coasts. It has only three barbels. The adult, reaching a length of twenty inches, is of a rich yellow colour spotted with chestnut-red. The very young are the little silvery mackerel midges, formerly known under the distinct name of *M. glauca*, and are to be found swimming at the surface of the water in June.

The Four-bearded Rockling (*M. cimbria*, Linn.) is rare in Cornish coastal waters.

Before leaving the family *Gadidae*, it may be mentioned that the young of such species as the pollack and the pout might almost be classed as inshore rock-fishes, since up to a size of eight or ten inches they keep very much to rocky parts round the coast.

Elsewhere the Common Eel (*Anguilla anguilla*, Linn.) has been dealt with fully, so it need take up no space here, though it may again be pointed out that it is far from being a purely fresh-water species during the period of its growth from the "elver" stage to the mature "silver eel," but frequents coastal waters, and may be found hiding under rocks at low tide.

The Conger (*Conger conger*, Linn.) is a frequenter of rocky places below the tide marks, and is a very important food fish. There is a great discrepancy between the respective sizes of the sexes, the males often not exceeding $2\frac{1}{2}$ -feet in length when arrived at full maturity, while the females may attain a length of ten feet, and a weight of well over a hundred pounds. There is little need to further describe so well known and common a fish. Like

other members of the *Anguillidæ*, the mature congers proceed to deep water to spawn, though they do not make anything like the long journeys of the common eels. The peculiar *leptocephalous* larvæ were for long known under the name *Leptocephalus morrisii*, and it was in connection with this form that Delarge, in 1881, made the discovery that eels had this distinct larval stage, and underwent a remarkable metamorphosis.

The Muræna (*Muræna helena*, Linn.) a peculiarly shaped eel that attains a large size, and is coloured vivid yellow, with irregular markings of brown and purple, has twice been recorded from the waters of the Cornish coast, a specimen having been taken at Polperro, in 1834, and another at Fowey, in 1866. It is a common Mediterranean species.

Before leaving the subject of Cornish fishes we may direct the reader's attention to the comparative frequency, taken in the aggregate, of the occurrence of typical Mediterranean species in Cornish waters. This fact is not easily explained, for a look at the map will show that there is no apparent easy access between the two regions. What probably happens is that Mediterranean species enter the Atlantic to find the warm current of the Gulf Stream skirting the coast of Spain. Swimming north against the current, but keeping always in warm water, they find themselves in the vicinity of Land's End, where they come inshore for food, or possibly shelter. It is evident that they do not survive there, or we should have many more records.

Another effect of the Gulf Stream is to bring to the Cornish coasts occasional visitors from the Tropical Atlantic. The Sun-fish (*Orthagoriscus mola*, Linn.) and its near relative (*O. truncatus*, Retz.),

the File-fish (*Balistes capriscus*, Gmel.), the Rudder-fish (*Pammelas perciformis*, Mitch.), and the gorgeous Opah, or King-fish (*Lampris luna*, Gmel.), all of which have been recorded from Cornish waters, may be included in this category.

CHAPTER XX

THE COLLECTING OF LAND SHELLS

EVERYBODY knows that the sea contains a great many different kinds of molluscs with beautiful or quaint shells, and most people have at some time or other made collections of the commoner kinds such as are to be found along the sea-shore. To most of us the lovely specimens from tropical seas that sailors and travellers in foreign parts bring home, or that are displayed in all their glory in our museums, are fairly familiar. Commonly we look upon the Mollusca as marine animals, and rightly so, for the marine forms undoubtedly predominate, while the whole group originated in the sea.

But how many people who take an interest in Nature, yet who have gone deeply into the study of her creatures, know that scattered through the world there are a great number of purely land-inhabiting molluscs, whose shells rival in beauty of form and colour those of the inhabitants of the vastly deep ; and that even in our own little islands there is a goodly array of these interesting animals ? They are, of course, familiar with the common garden snail, and probably also with the pretty, banded white-lipped and brown-lipped snails, for these are conspicuous garden and country forms. Doubtless they know that there are some smaller forms that are to be discovered under stones, but

the real number and significance of the different species that occur are hidden from them.

And, all things considered, they are hardly to blame for this, since, not only are the greater part of our British land-snails small and inconspicuous, many of them at a casual glance closely resembling each other, but they are nearly all nocturnal in their habits, hiding up during the day under stones, in the debris at the roots of the underbrush and grass, or in cracks and crannies in rocks, old walls, and tree-trunks.

Perhaps it would surprise the average reader if he were told that our party, while canoeing on the Thames between Taplow and Cookham, stepped ashore in Cliveden Woods and in half an hour found on the slopes there no fewer than sixteen different kinds of land-snail, representing two order, five families and numerous genera. Yet such was the case, nor have I any doubt that there were many other species not discovered by us in those woods. The sixteen species cannot be said to represent adequately the terrestrial *Mollusca* of the Thames Valley. Altogether there are well over eighty species of land inhabiting snails and slugs known to occur in the British Isles.

The discovery of so many different forms of land-snails naturally stimulated our interest in the subject, and having duly labelled and put away in small boxes series of each of the species we had found in Cliveden Woods, we continued our search for these interesting molluscs when we reached Bath a few days later. There, in the course of one or two walks in the outskirts of the town, hardly away from the dwellings of man, we found some ten distinct species.

The collection was further augmented when we

got to Penzance in Cornwall, and it is mainly the Cornish forms that will be dealt with here, though the other may be mentioned.

By far the greater number of the land inhabiting molluscs of the British Isles belong to the order *Pulmonata*, of the class *Gastropoda*. The latter, of course, contain all the univalves, or one-shelled molluscs, that move upon the flat surface of their single muscular "foot." They mostly have the shell with a spiral, which may be small or large, depressed, rounded, or long drawn-out and pointed. The limpits and a few similar forms are the exceptions in which no spiral exists. The *Pulmonata*, as the name suggests, possess what may be called a lung instead of the various forms of gills, that occur in the marine gastropods and a few fresh water forms. This lung consists simply of a cavity inside the mantle at the front, and air reaches it by means of a pore on the right side of the animal.

The Pond Snails (*Suricula*, *Ancylus*, *Limnæa*, and *Planorbis*) and their terrestrial and semi-terrestrial relations the Herald-shells (*Corychium*) and Bladder-snails (*Physa*) belong to the *Pulmonata*; and should not be confused with the River Snails (*Vivipara*) and their other fresh-water relatives the Valve-shells (*Valvata*) and Bithynias (*Bithynia*), for these belong to a totally different order, the *Prosobranchiata*, whose members are mainly marine, and breathe by means of a gill-plume that lies in front of the heart. These may at once be recognised by the fact that they possess an operculum, or little, flat, rounded door to the mouths of their shells.

Now the purpose of this little door is undoubtedly protective, and, though, in the case of many marine forms, it has been developed to keep out harmful

enemies, in these riverine forms, and the littoral species, such as winkles, its chief function would appear to be to keep the animals from desiccation during their frequent and sometimes protracted periods of exposure to the air, especially when we consider that the latter breathe by means of gills and not a lung cavity. The pond-snails, and their relations, like the true land-snails, breathe by means of a lung, so they do not need a door to close them in when the ponds they inhabit become dried up. In fact, you may watch them floating "foot" upwards on the surfaces of the ponds for the very purpose of breathing air.

The presence of the operculum in such marine molluscs as the winkles, dog-whelks, and top-shells is very interesting, for it will be found that these forms, living, as they do between tide-marks are frequently left high and dry, and so, like the river-snails, need some special means of shutting out the dry air.

It so happens that there is one British terrestrial snail that possesses an operculum, and this is the Round-mouthed Snail, known to science as *Cyclostoma elegans* (Mull.), sometimes generically as *Pomatias*. It does not belong to the *Pulmonata*, but to the *Prosobranchiata*, and is closely allied to the river-snails (*Vivipara*) and the marine winkles (*Littorina*), from some form of the latter of which it is supposed to have evolved comparatively recently. We found numerous specimens of this interesting species in Cliveden Woods, and also on Beechen Cliff, at Bath, but though recorded from Cornwall, it is very rare there, and we did not come across it. Undoubtedly we have in this species a form of winkle that first began by inhabiting the shore between tide-marks, and then by degrees

took more to the land, probably following up river estuaries, till at last it became purely terrestrial, forsaking its mother element, the sea, altogether. Possibly it became a fresh-water species first, like *Vivipara* and *Valvata*, both of which may be in an evolutionary stage from sea to land. We see in the very much thinner shell of the round-mouthed snail a response to its less trying environment, for the true winkle undoubtedly owes its thick, hard shell to the buffetting that it and its kind have had to stand from the pounding of the sea waves on the rocky shores they inhabit. The evidence we see of this change from sea to land on the part of many sea-shore animals is one of the most interesting features of this very interesting fauna, and we have had occasion to call attention to it more than once in these pages.

In this connection it may be mentioned that there are a few members of the order *Pulmonata* in the British Isles that form, as it were, a connecting link between the present terrestrial state of the majority of these molluscs and a very remote marine state. These are such small species as the Little Ear-shell (*Otinia otis*, Turt.), the two-toothed *Leuconia* (*Leuconia bidentata*, Mont.) and the Toothed *Alexia* (*Alexia denticulata*, Mont.), all of which inhabit the rocks of the sea-coast between tide-marks, and have been recorded from various places on the Cornish coasts. These, apparently, represent the transitional stage of the pulmonates, and give the clue to the marine origin of the latter.

As we did not collect any pond or fresh-water snails in Cornwall, the group will not be dealt with here, though, in order to make the subject quite clear, it may not be out of place to state that they represent the sub-order *Bassommatophora*,

in which the members have the eyes at the base of the tentacles instead of at their tips. The other sub-order is the *Stylocephalophora*, and it includes all the land-slugs and true snails, in all of which the eyes are situated at the end of the retractile tentacles.

Of these, the slugs might almost be dismissed as being somewhat unsuitable as specimens for collections, were it not for the fact that they are in themselves very interesting animals. They can only be preserved in alcohol or formalin solution, and in this condition, by reason of the way they contract into shapeless lumps are anything but attractive. It may, however, be stated in passing that certain slugs, to wit, the members of the genera *Liman* and *Amalia* of the family *Limacidae*, have, hidden away in their mantles and protecting the respiratory chamber, or lung, a small scale-like shell, specimens of which may be picked up from time to time, and which would puzzle the tyro as to their origin. The *Testacellidæ* or carnivorous slugs, have a small external shell situated at the extreme posterior end of the dorsal surface, where it covers the breathing apparatus.

Including the members of the genus *Arion*, such as the garden slug and the black slug, in which there is no vestige of a shell, some thirteen species of a slug have been recorded from Cornwall.

We found the shell of Mange's Carnivorous Slug (*Testacella maugei*, Feruss.) at St. Ives lying amongst the empty shells of the Pointed Snail *Cochlicella barbara*, Linn.) at the base of a wall. This is an interesting species that is supposed to have been introduced into England from south-western Europe about the year 1812, when it was first discovered by Drummond in some nursery gardens at Bristol,

whence it has spread to many other parts of the country. Recently, however, Mr. B. B. Woodward, writing on the non-marine molluscs of Cornwall in the "Victoria History," states that owing to its recent discovery "in a holocene rain-wash at Porlock Weir near Minehead, in a spot too remote from habitation to permit of its presence being accounted for introduction, this species must now be held to be indigenous to the British Isles." The carnivorous slugs owe their name to the fact that they prey upon earthworms, which they pursue into their burrows, under ground, capture and devour. The other slugs are herbaceous in their diet.

Closely related to the slugs of the genus *Limax*, in fact included in the same family, *Limacidae*, are a number of small snails of the genus *Hyalinia* (sometimes called *Vitrea*), which are connected with the slugs through the small-shelled Pellucid Glass-snail (*Vitrina pellucida*, Müll.). Though we did not secure specimens of this very thin-shelled species, it is said to be common in certain localities. It has been suggested that this snail represents an ancestral form, from which the slugs of the genus *Limax* have evolved by the suppression and covering up by the mantle of the shell. To the *Hyaliniæ* belong the Cellar Snail (*Hyalinia cellaria*, Müll.), a rather flat, light-coloured species that is very common, and may be found under stones and logs, in the debris of hedges and in cellars, from which fact it derives its name. It measures about half-an-inch in diameter. Very similar, but larger and more reddish brown in colour, is Draparnaud's Snail (*H. draparnaudi*, Beck.), which has only been recorded from Falmouth and Torquay in Cornwall, and from but these three other places in the British Isles namely, Bristol, Isleworth and

Guernsey. A species which we found fairly common in the area round Penzance, as well as at Bath and in Cliveden Woods, is the Shining Snail (*H. nitida*, Müll.). This is remarkable for its very smooth and shiny surface, the transparent, and flattened shell being of a rich brownish colour, through which the black animal may be seen. The species is further characterised by the development in the adult female organ of a little shaft of calcite, called the Love Dart, which, when two snails are about to mate, are discharged from each into the other, apparently to excite the sexual instinct. It may here be noted that all the members of the order *Pulmonata* are hermaphrodite; *i.e.* they possess both male and female organs, both of which function simultaneously.

Somewhat like *nitida* in appearance, but larger and with light rays across the whorls is the Glossy Glass Snail (*H. glabra*, Stud.), also recorded from Cornwall, and found by us under stones and logs near Penzance.

A very pretty though small snail that we found plentifully on old walls, logs, and other such places, is the little Rounded Snail, which is known to science as *Pyramidula rotundata* (Müll.) and which, with the following species, belong to the family *Helicidæ*, or true snails. This snail may be described as flattened, with a deep and wide umbilicus (the hollow that occupies the centre of the spiral in some shells), and a keeled margin, or outeredge, to the spiral and body-whorl. It is of a dull yellowish colour, bounded with reddish-brown, which markings may be clearly seen in spite of the small size—one quarter of an inch in diameter—of the shell. An even smaller species, the Rock

Snail (*P. rupestris*, Drap.) also occurs in Cornwall, though we did not secure specimens.

The very common Ruddy Snail (*Hygromia rufescens*, Penn.) and the Silky Snail (*H. granulata*, Ald.) we found fairly abundant in the vicinity of Penzance, where they occurred on the leaves of such plants as stinging, nettles and ferns, the latter especially in wet weather. Of these two species the ruddy snail may be recognised by its dark reddish-grey colour, and wrinkled whorls. It is about half-an-inch in diameter, and when young is covered with short hairs, which fall off before maturity is reached. The silky snail is less flat, smaller, and is covered in the adult with fine hairs. It is more rounded than the Bristly Snail (*H. hispida*, Linn.), another hairy species which has also been recorded from Cornwall, along with the Green Hairy Snail (*H. revelata*, Fer.) and the Dusky Snail (*H. fusca*, Mont.) but which we did not ourselves note. The Prickly Snail (*Acanthinula aculeata*, Müll), a related though very small form, in which there is a row of small spines following the middle of the spiral, has also been recorded from this county.

Several members of our next group, *Helicella*, have been recorded, but the Banded Snail (*Helicella virgata*, Da C.) is, perhaps the commonest. In this species the shell is more rounded than in most of the foregoing, the spiral is low conical, and there is a broad brown band following the spiral just above the periphery of the whorl with several smaller bands of the same colour below it. The ground colour of the shell is creamy white. The species attains a size of a little over half-an-inch in diameter, and is extremely common. We found it abundant amongst the grass stems growing on the low-lying

sandy areas between Penzance and Marazion. Side by side with the dark-banded specimens were numerous others, apparently representing a light colour-phase, in which the bands are sandy coloured instead of brown. The Wrinkled Snail (*H. caperata*, Mont.) closely resembles the banded snail, but is smaller and has the shell more strongly wrinkled by the growth-bands. The dark bands are more or less broken, especially the lower ones, while the shell is flatter than that of the banded snail. It may be found in the same places as the latter.

Equally abundant with, and occupying the same places as, the banded snail is the quaint little Pointed Snail (*Cochlicella barbara*, Linn.), easily recognised on account of its long drawn out and pointed spire. Of a pale sandy-cream colour it is banded across the whorls with dark brown, with a dark band low down following the direction of the spire on the last, or body, whorl. This species and the two foregoing are said to be greatly liked by sheep, who eat them with avidity as they cling to the stems of the grass upon which the latter graze. On this account they are called "sheep snails" by the Cornish farmers, who also attribute the fine flavour of down-fed mutton to the fact that the sheep eat so many of these snails in the course of their grazing. We secured specimens of all these three species at St. Ives and at Kynance Cove in the Lizard, as well as in the Penzance district.

The Sandhill Snail (*Helix pisana*, Müll.) is something like the banded snail, but is considerably larger, and has the dark bands finer, with numerous short streaks branching obliquely from some of the bands. It has been recorded from the sandhills of Whitsand Bay, St. Ives, and from Falmouth. It is said to feed upon the sea Holly (*Eryngium*

maritimum). As some of this grows on the sandy parts above the tide-marks between Penzance and St. Michael's Mount, we searched for specimens of this snail, but failed to find any, though large and somewhat irregularly marked specimens of the banded snail were at first mistaken for it.

We now come to two very common species that should be familiar to everyone, and whose great variety in markings and beauty of colour should appeal to the collector. These are the Brown-lipped Snail (*H. nemoralis*, Linn.), and the White-lipped Snail (*H. hortensis*, Müll.), distinguishable from one another, as the names suggest, by the different colouring of the lip, or rib of the mouth, and by the smaller size and slightly flatter shape of the latter. In both species the ground colour ranges from pale creamy white and yellow to a rich yellow or salmon pink, while the dark-brown bands that follow the spiral may be numerous and narrow, few and broad, few and narrow, reduced to a single one, altogether wanting, or completely coalescent, so that the whole shell is dark-brown. Of the brown-lipped snail, we found most of these variations, except the completely brown form. The white-lipped species was less common, and of it we found one beautiful variation in which the ground colour was pale yellow marked with five longitudinal bands of white.

It is almost superfluous to say that the Common Garden Snail (*H. aspersa*, Müll.), which needs no description here, was found to be extremely abundant.

Something like this species, but smaller, about the size of the white-lipped snail, is the Copse Snail (*Helicigona arbustorum*, Linn.), which has been recorded from Cornwall, but specimens of which

we did not secure. This species is light brownish, spotted thickly with a light yellowish colour, and having a single longitudinal dark band following the spiral just above the periphery of the whorls. It is an inhabitant of woods and copses. We found it at Bath as well as very abundant in Cliveden Woods.

Besides these snails there are others in which the spirals, like that of the pointed snail, are drawn out such as the members of the genera *Buliminus*, *Pupa*, *Balea*, and *Clausilia*—all belonging to the family *Pupidæ*, the name being derived from the chrysalis or pupa like shape of the shells. Indeed, many of them might easily be mistaken for the pupa of some moth as they lie under a stone or log, or in the cracks of old tree stumps. Species belonging to all these and several other genera have been recorded from Cornwall, but though we secured specimens in other places mentioned, we did not get any in the latter county.

We have already glanced at the slugs but definite mention may be made of a few belonging to the genus *Arion* which are classed by systematists with the *Helidicæ*. Of these the Black Slug (*A. ater*, Linn.), and its variety *bicolour*, the Dusky Slug (*A. subsufuscus*, Drap.), the Garden Slug (*A. harteni*, Feruss.), and a fourth species called *A. circumscriptus*, Johnst., are prevalent in the county.

CHAPTER XXI

SOME SEA SHELLS

“ See what a lovely shell,
 Small and pure as a pearl,
Lying close to my foot,
Frail, but a work divine,
 Made so fairly well
With delicate spire and whorl,
 How exquisitely minute
A miracle of design ! ”

—Tennyson.

IN writing upon such a subject as the marine conchology of any part of the British coasts one is haunted by the knowledge that there is hardly anything to say about the many species of shelled molluscs that infest our shores that has not already been said repeatedly and a great deal better than one can ever hope to do.

Conchology as a branch of zoological research and study had attained a great popularity in this country and on the Continent a hundred years ago and more. It has always been a popular subject with naturalists, in consequence of which fact there exists today a vast literature upon the sea shells of this and other countries. Popular works on the British species exist, one was going to say by the score, but in sufficient numbers at any rate to enable those who wish to study the subject without much difficulty. But, like the birds of our islands and their eggs, the sea shells are of perennial interest,

and no book purporting to deal with the life of the seashore could be considered complete without some contribution to the subject of marine conchology.

Besides, we are supposed to be describing, more or less, the biological experiences of three holiday makers in the Cornish Peninsula, and since the finding and identifying of sea shells formed no small part of those experiences, it behoves us to say something of these interesting animals and their shelly remains, the latter, by the way, usually being the only parts of the various species that figure in cabinet collections or in the plates of books upon the subject.

Following, then, the general plan adopted in these pages, and in order to fulfil a duty to the reader, we may discuss and briefly describe a number of species that were actually found by us in the vicinity of Penzance, Mount's Bay, St. Michael's Mount, and other places on the Cornish coast ; and it is hoped that this will prove sufficient to introduce the subject, especially to such of our readers as have not given it the attention it deserves, but wish to become more acquainted with it in the future.

But before going into details regarding these species, of which some thirty-four were collected by us out of a total of four hundred and twenty-seven recorded from the Cornish littoral and adjoining waters, and none of which by any stretch of imagination could be looked upon as anything but the commonest of forms, a few general remarks upon the marine *Mollusca* and their classification may be indulged in, in order to assist the beginner, a person, by the way, who has our entire sympathy, but who often receives but scant consideration from biological writers.



(Photo by A. de C. Sowerby)

Searching under the weeds for the rarer Crustaceans and Molluscs



(Photo by A. de C. Sowerby)

Barnacles, Purples, and Limpets on a rock, with strands of the Sea-thongs weed (*Himanthalia*), and a bunch of the red *Rhodymenia*

The critical reader might be tempted to ask whether thirty-four species is not a very small proportion of the very large total divulged above for three collectors to find on a shore so admittedly rich in animal life as that of Cornwall, to which it may be replied that the actual number of littoral species, that is, species that inhabit the shore about and between tide marks, is never very great, by far the greater part of the shell-bearing molluscs preferring deep water. The shells of these may only be found when cast ashore by the fury of the waves in stormy weather, and late summer is far from being a favourable season for this. Besides, a great many of the species recorded from Cornish waters have been secured from dredges, some even from the stomachs of certain demersal fishes, and have never been found on the shore.

As regards their distribution along the sea coast the marine molluscs may be divided into two, arbitrary classes ; those that inhabit the rocks ; and those that live usually buried in the sand or mud of the open shore. Generally speaking, the former will be found to be mainly Gastropods with thick, hard shells and opercula, or doors to the shell mouths ; while the latter will prove to be mainly bivalves, or Pelecypods. The latter, it will be found, however, are pursued into their hiding places by certain carnivorous Gastropods, which do not, as a rule, inhabit the rocks. The common mussel, of course, abounds on the rocks, and there are one or two other hard-shelled bivalves that may be sought amongst the rocks. Piddocks, and the like, must also be looked for in rocky places, since their habit is to find security by boring into the rocks themselves. They thus escape the greatest enemies of all shelled molluscs, the sea stars, or starfishes,

who devour Gastropods and bivalves alike. The bivalves of the rocks, notably the mussels, are attacked and eaten by such univalves as the periwinkles and purples ; and here it may be pointed out that the Gastropods are mainly carnivorous, while Pelecypods, or bivalves, depend entirely for their nourishment upon the minute animal and vegetable organisms that are carried in suspension in the water, and in the aggregate are known as Plankton.

The reader will have remarked by now that there are at least two groups or divisions of molluscs. As a matter of fact there are four, some systematists insisting upon five ; but the two already mentioned concern us most. The four natural classes into which the great phylum *Mollusca* is divided are :—

1. *Pelecypoda*, which contains all the bivalves, or molluscs in which there are two valves joined by a hinge, and enclosing the animal.
2. *Scaphopoda*, a small class which contains the single-shelled Tusk-shells.
3. *Gastropoda*, all the rest of the single-shelled molluscs, that progress usually by means of a "foot," having eyes, mouth, and in most cases a spiral shell.
4. *Cephalopoda*, to which belong all the squids, sepias, cuttles, octopuses, and nautali ; all of which, except the last, have no external shell, though possessing some form internally.

The head is provided with arm-like tentacles.

We are not concerned here with the last, while the second, the *Scaphopoda*, may be dismissed after mentioning the fact that but two species, the Elephant Tusk-shell (*Dentalium entalis*, Linn.), and the Common Tusk-shell (*D. vulgare*, Da Costa) have been recorded from Cornwall. These two shells will at once be recognised by the finder :

their shape betrays their name. It may be noted, however, that their small, tusk-like shells are open at both ends, while the animal, if found within, presents a somewhat different appearance from any of the other single-shelled molluscs. There is a primitive head, without eyes, though a mouth with a toothed radula, or tongue, is present. A bilobed foot and an enveloping mantle are also present, as well as a rather simple, paired liver and sexual organs, but heart, circulatory system, and respiratory organs are missing. There are a number of knobbed, filamentous tentacles round the mouth, used to capture and draw to the mouth the animal's prey.

Of the class *Pelecypoda*, sometimes called *Lamellibranchia*, a more recent name over which the former takes precedence by right of priority, our small collection contained some fifteen species, while the number of species recorded from Cornwall is a hundred and forty-one, or about a third of all the molluscs known from this region. The class is divided up into orders according to the nature of the gills, which lie on either side of the body and foot, between the latter and the two mantle-flaps, which in turn are enclosed by the valves of the shell. In the members of this class there is no head, nor are there any eyes, while the mouth has neither jaws nor tongue, but is one of a pair of siphons through which a continual current of water is kept passing by means of cilia that fringe the lips. This current supplies the gills with oxygen and the animal with nourishment in the form of minute particles of animal or vegetable matter, as well as living organisms carried in suspension. The muscular foot is blade-shaped, sometimes very small, and the animal does not progress by creeping

upon it, but by being pushed along by it. The body is held between the outer valves by means of powerful adductor muscles, which also keep the valves closed. If the animal wishes to extrude its foot or siphons, it relaxes these muscles, when the elastic hinge of the valves immediately pulls them open.

The *Gastropoda* are very different. They have a head, usually eyes, mouth, with a toothed tongue, or radula, and a large, flat muscular foot, upon which they creep over the rocks or sea bottom. The single valve, or shell, is usually spiral. Inside is a mantle covering the main part of the body. Its edge secretes the material of which the shell is built. The marine *Gastropoda* are all supplied with plume-like gills. They possess a heart, kidney, liver, and circulatory system, and altogether show a great advance on the *Pelecypods*. Some 271 species are recorded from Cornish waters, our collection containing some nineteen forms.

Taking first the *Pelecypoda*, of the fifteen species collected by us all but three belong to the order *Eulamellibranchiata*, and are characterized by the fact that the gill filaments have become laterally joined to one another to form gill-plates, which are completely folded back each upon itself, and having the margin adherent to the mantle in the outer pair and to the base of the foot in the inner pair. The spaces inside the folds are traversed by interlamellar junctions. "

Of the other three species, one, the Quin, or Queen Scallop (*Pecten opercularis*, Linn.) belongs to the *Pseudolamellibranchiata*, in which the gill-plates differ from those of the foregoing only in the absence of any interlamellar junctions inside the folds of the gills ; while the other two, the Common

Mussel (*Mytilus edulis*, Linn.) and the Saddle Oyster (*Anomia ephippium*, Linn.) belong to the simpler *Filibranchiata*, in which the gills are in the form of numerous long filaments that are folded back upon each other, and show some signs of being laterally joined to each other, but the tips are free.

Two other orders are included in the class *Pelecypoda*, namely the *Protobranchiata*, in which the gills consist of simple, free, unbranched filaments that are not folded back; and the *Septibranchiata*, in which the gills are neither filamentous nor in the form of plates, but are replaced by a punctured, muscular partition that joins the base of the foot to the mantle and leaves a space above it which might be called a branchial cavity. But neither of these two orders concern us here. They are both very small, the former of the two being represented in Cornish waters by but two species of Nut-shell (*Nucula nucleus*, Linn. and *N. nitida*, Sowerby) and the latter by a single species, *Cuspidaria cuspidata*, Olivi.

The quin, or queen scallop, is a very beautiful shell, with well ribbed and fan-shaped valves, that show pretty red, pink, purple and white variegated or clouded markings. One of the chief points of interest about this and other scallops is that at times they move through the sea with a flitting, butterfly-like motion, produced by rapidly opening and closing their valves. They inhabit rocky areas below low-tide mark, and only their empty shells are to be found cast ashore. Some small specimens that we secured from the lobster pots at Penzance I have referred to this species, though they may represent one of the smaller species. Full grown shells of the quin were also found on the rocks. The Great Scallop (*Pecten maximus*, Linn.)

that we see in fishmongers' shops, and forms so dainty a dish on our tables, is recorded as irregularly distributed round the coasts from the level of the *Zostera*, or Sea-grass, beds down to at least 30 fathoms. We did not come across it.

To this order also belongs the Oyster (*Ostrea edulis*, Linn.), which is cultivated in valuable beds at Falmouth, up the Tamar River, and in the Helford River.

The Common mussel needs no introduction to the reader. Its characteristic purplish-black shells occur in clusters on rocks, pier pillars, groins, everywhere, in fact, where they can secure a firm hold by means of the hair-like filaments, called the byssus, which are spun by the foot. This form of mussel, as its classical name indicates, is edible, and it is a valuable source of human food. Other forms, as, for example, the Horse-mussel (*Modiola Modiolus*, Linn.) are not fit for human consumption. The latter, classed by some authorities in the genus *Volsella*, is not at all common in Cornish coastal waters.

The beautiful little pearly-shelled saddle-oyster may be found on other shells and rocks. Its lower valve is flat with a hole in it, through which a calcified byssus passes, attaching the animal to the rock. The upper valve, which is really the left one, is rounded and crinkly. Very common in these areas, this species was frequently seen and gathered by us, but the fragile nature of the shells render them difficult to keep intact.

The order *Eulamellibranchiata*, whose distinguishing feature we have already noted, is by far the largest section of the Pelecypods. All the rest of the bivalves to be dealt with here belong to it.

Six members of the family *Veneridae* were collected

by us in the Penzance district. These were the Smooth Venus (*Venus chione*, Linn.), the Banded Venus (*V. fasciata*, Da Costa), the Pale Venus (*V. casina*, Linn.), the Striped Venus (*V. gallina*, Linn.), the Rayed Artemis (*Dosinia exoleta*, Linn.), and the Pullet Carpet Shell (*Tapes pullastra*, Linn.). Of these the smooth Venus is much the largest and most handsome, being a fine biscuit-brown colour, banded lighter both radially and concentrically. The valves are of medium depth, and measure up to three and three-quarters of an inch across. They are thick and smooth. Empty shells may be picked up after stormy weather on the beaches. One specimen only was secured at Penzance by us. The animal lives buried in the sand below low-water mark.

The banded venus may be recognised by its somewhat rounded, rather flat valves, which are deeply and concentrically ribbed, the ribs being sharp edged. The valves are variously coloured from yellowish and pinkish to brown, and are marked by rays of a deeper tint. The pale venus is whitish, with deeper valves, and the concentric ribs more plate-like than in the banded venus. It is also considerably larger, being an inch and three-quarters across, whereas the banded venus is not more than three-quarters of an inch in diameter. The striped venus we found very much more common than either of the two foregoing, living specimens being found in the sands near low-water mark. In this species the valves are more triangular in shape, of medium depth, concentrically, but less deeply ribbed, pale in colour with three bands of striated brownish markings radiating from the beak. The inner margins of the valves are milled as in both the foregoing.

The rayed artemis has very round valves, finely

concentrically ribbed, rather flat and saucer-like, the inner edges not milled. They are of a cream colour faintly rayed with reddish brown. The species is said to be common in sandy bays from low-water to about forty fathoms. We secured empty valves on the sand in Mount's Bay.

The pullet carpet shell is common in the sands near rocks, as well as elsewhere, and its empty valves may at times be found littering the rock-pools, in the sand at the bottom of which live shells may be found. We also found live specimens in the black mud of the harbour bottom when looking for worms. The species may be recognised by its somewhat oblong and not very deep valves, which are finely concentrically and radially ribbed. They are of a pale cream or sandy colour, more or less covered with dart-shaped brown or greyish markings. Next to the common mussel this is the most abundant bivalve of these shores.

Of the family *Mactridæ* three species were secured by us. The Rayed Trough Shell (*Mactra stultorum*, Linn.) has the shell somewhat triangular in shape, rather shallow and thin, shiny, and of a pale cream colour rayed with a deeper shade. The Thick Trough Shell (*Spisula solida*, Linn.) is very similar in shape, but is smaller and has the valves thicker and more solid, not shiny, whitish, and plainly but sparsely concentrically ribbed ; while the Cut Trough Shell (*S. subtruncata*, Da Costa) is smaller still, even more triangular, and with the concentric ribs very numerous and closely set. All three species live in the sands at no great depth from above low-water mark seaward.

The *Donacidae* are represented by the pretty little Bahded Wedge Shell (*Donax vittatus*, Da Costa), which may be recognized by its shallow, elongate,

rather thin valves, which are delicately ribbed radially, and marked with alternate yellowish and purplish concentric bands. The inner edge of the valve is milled. Empty shells are commonly washed up and may be found on the sands at low tide, the species burrowing in the sand in the vicinity of low-water mark.

The Common Cockle (*Cardium edule*, Linn.) may be found buried in the mud in the harbour bottom when the tide is out. It may at once be identified by its very pronounced radial ribbing. It belongs to the family *Cardiidæ*, and is well known as an article of food.

The *Tellinidæ* have the shell usually thin, finely concentrically ribbed and of a shiny delicate appearance, the animals having a large foot and very long divided siphons, which enable them to remain at some depth under the surface of the sand. We secured specimens of only one species, namely, the beautiful little Thin Tellin (*Tellina tenuis*, Da Costa), whose delicate pink and white shell may be picked up on the sands at low tide. This is a small species with flat, shiny valves, in which the finest of concentric ribbing is discernable. Its home is in the sands, not very deep down, in the vicinity of low-water mark.

A common bivalve, but one of whose shell it is not always easy to find a whole specimen, is the Common, or Pod Razor Shell (*Solen siliqua*, Linn.). But if careful search is made amongst the low-lying rocks and loose stones that occur in Mount's Bay, near the Penzance end of the beach, fine empty valves, measuring as much as eight inches in length may be found. As a matter of fact the razor shell lives in the sand low down on the beach. There it assumes a vertical position with the foot pointing

down and the short siphons up, close to the surface. The animal not infrequently leaves this retreat and may be found lying more or less helplessly on the beach. When in its burrow the presence of the latter may be detected by the little squirt of water that the animal ejects as it retreats on becoming aware of the intruder's approach. The Pod razor may be recognized by its large, rather broad, and straight valves. The Sword Razor (*Solen ensis*, Linn.), is smaller, narrower, and has a more or less pronounced curve, which gives the shell the appearance of a sword scabbard. The family to which these species belong is known as the *Solenidae*, and it is represented in Cornish waters by seven species.

The last of the bivalves to be considered here is by no means the least interesting. This is the Common Piddock (*Pholas dactylus*, Linn.) of the family *Pholadidae*, all the members of which have the habit of boring into rocks—in one case, the Wood Piddock (*Xylophaga dorsalis*, Turton) into wood—where they live in comparative security. In the members of this family the shells are anything but thick and strong, in one species, the Paper Piddock (*Pholadidea papyracea*, Turt.), being extremely thin. Thus one can readily see how necessary it is for them to seek some shelter, and the means they have devised is an excellent one. Once inside a burrow the piddock remains there for life enlarging it as it grows. The common piddock is the largest of the British species, reaching a length of as much as five inches. Its valves are of a white colour, with a chalky appearance. They are ~~pro~~nouncedly and radially ribbed with wavy ridges, while there is a peculiar spoon-shaped and curved projection from the hinge-plate inside each valve,

that serves as an attachment for the muscles of the body. This is called the apophyse. On the exterior of the hinge-plates there are what are called the dorsal shields, consisting of two lateral valve-like plates, which interlock posteriorly with a small transverse plate, followed in turn by a long shield lying longitudinally. The valves may be described as being something the shape of the folded wings of a bird. They gape widely at both ends, exposing the rather small foot at one end, and allowing the two, rather long, and jointed siphons to project at the other, and so to obtain access to the mouth of the burrow. We found several broken valves amongst the rocks below the Railway Station at Penzance, but did not discover any living specimens in their burrows. The species is said to bore into "shale, friable slate and sandstone, but apparently has not been found in granite." It is recorded from both Marazion and Penzance.

We may now leave the bivalves and examine the univalves, all of which, except the tusk-shells, which have already been disposed of, belong to the great class Gastropoda.

The first group to be considered is the rather interesting one called *Amphineura*, which some authorities consider as a separate class, and others as not more than an order. In order not to complicate our subject we have decided to give it only the latter rank and place it with the Gastropods. This order includes the so-called Mail-Shells, or Chiton, in which the shell is divided into eight dorsal plates that overlap from front to back, and articulate each with its neighbours. Their sides are embedded in a stout fleshy mantle which encircles the animal. Under this mantle on either side of the powerful foot are the gills, each a row of little

plume-like appendages. The animal has a head and a mouth with a toothed radula, but no eyes. It clings to the surface of rocks or stones in the same manner as the limpet, but when alarmed can curl up like a pill-bug into a ball with the shelly plates outside. The British species are small, and owing to their habit of hiding under stones are not easy to find.

Certainly they are far from familiar to the average person who collects shells at the sea-side. Though some eleven species have been recorded from Cornish waters, we secured specimens of but one, the Grey Mail Shell (*Chiton cinereus*, Linn.), which appears to be fairly common, clinging to the under surfaces of stones near low-water mark. This is a small animal, the largest specimens measuring under an inch in length.

The rest of the Gastropods are divisible into three orders, namely, the *Prosobranchiata*, in which the plume-like gills are situated in front of the heart ; the *Opisthobranchiata*, in which these organs are behind the heart ; and the *Pulmonata*, which are mainly terrestrial, or fresh-water in their distribution, and breathe by means of a cavity formed by the union of the mantle with the neck. All the species of univalve that we have to consider here belong to the first of these orders, the second comprising the sea-slugs and their allies, and the third, the land and fresh-water snails, with a very few littoral species occupying the upper part of the between-tide marks zone.

The first family to come under our notice is that containing the well-known limpets, and is known as the *Patellidae*. The Common Limpet (*Patella vulgata*, Linn.) swarms everywhere on the rocks round our coasts, and should be too familiar to need

much description. It is very variable. The cone-like shell may be tall or low, the radial ribs coarse or fine, and the margin almost smooth or deeply notched, or denticulate. There is also much variation of colour, the inner surface of some of the shells being extremely beautiful. Names have been given to the varieties, but we need not bother with them. It is hardly necessary to say that specimens of most of them were secured, for they occur abundantly everywhere. Limpets are edible and well suited to human consumption.

Another species of limpet secured by us, and belonging to the same family is that known as the Blue-rayed Limpet (*Helcion pellucida*, Linn.), which may at once be recognised by its smooth and thickened margin, the brownish colour of the shell, with, in a good example, radial markings. These last in young specimens are of a beautiful, pale iridescent blue. The species frequents the stems and fronds of the large weeds, such as *Laminaria*, in the vicinity of low-water mark, and it attains a length of about an inch, with a width of a little less.

Mention should be made of the Little Keyhole Limpet (*Fissurella græca*, Linn.) of the family *Fissurellidæ*, which has been recorded from Cornish waters, and which may be recognized at once by the presence of a little hole at the apex of the shell; and of the White Tortoiseshell Limpet (*Acmaea virginea*, Müll.), of the family *Acmaeidæ*, also recorded, and distinguishable by its flat smooth-margined, somewhat rounded and variegated shell.

A group of shells that are extremely abundant in, and characteristic of the Cornish littoral, specially in the Coralline Zone, are the Top Shells of the family *Trochidæ*. Four common species occur, namely, the Thick Top (*Trochus lineatus*, Da Costa),

the Flat Top (*T. umbilicatus*, Mont.), the Grey Top (*T. cinerarius*, Linn.), and the Common Top (*T. zizyphinus*, Linn.). Of these the first may be recognised by its thick shell and large size, some specimens measuring an inch and a quarter in height, and over an inch in diameter at the base. It is of a sandy ground colour with numerous reddish-purple, closely set, zig-zag markings. It is conical in outline, and has six whorls, the spire being rather pointed. There is no umbilicus in this species by which feature small specimens may at once be distinguished from the next species. We found it very common amongst all the lower rocks and in the rock-pools at Penzance.

The flat top shell may be distinguished from the foregoing species by its much smaller size, lower spire, and the presence of a pronounced umbilicus, or hollow occupying the centre of the spire. Its colour is dull cream, strongly rayed with crimson-purple bands, which may be broad and wide-set, or narrow and close together. This species is predominantly abundant in the rock-pools amongst the weeds.

Almost equally common in the same situations is the grey top shell, which may be distinguished at once by its taller spire, and buff ground colour with very close, finely interrupted grey bands. It is finely and closely ribbed in the direction of the spiral.

The common top shell is really the least common of the four species and to find it the collector must search beneath the loose stones and weeds in the rock-pools or low down amongst the rocks. It is pyramid-shaped with numerous ridges on the whorls parallel with the spiral, of a blue-grey colour with

reddish spots at regular intervals along the periphery of the whorls. It comes next in size to the thick top shell.

Related to the top shells is the beautiful little Pheasant Shell (*Phasianella pulla*, Linn.) a single specimen of which was found on the weeds in a rock-pool at low tide. This species belongs to the family *Turbanidae*. About a third of an inch in length, it is of a whitish ground colour prettily marked with bright crimson. The shell is somewhat top-shaped and has a very shiny surface.

All the foregoing univalve shells, except the Chitons, belong to the sub-order *Diotocardia*, all but the limpets having two auricles to the heart. The species that we are now going to consider, having only one auricle, are placed in a sub-order *Monocardia*, and of it species belonging to but five families concern us here. These are the *Littorinidae*, or winkles, the *Cypraeidae*, represented by but a single species, the little European cowry, in our region, the *Muricidae*, or purples and sting-winkles, the *Certhiidae*, or needle-shells, horn-shells, and the like, and the *Nassidae*, or dog whelks.

The members of the first are both well known and abundant. The Common Winkle, or Periwinkle (*Littorina littorea*, Linn.), is *par excellence* the inhabitant of the rocks of the foreshore. Its shell is too familiar to need description, while the animal itself is probably well-known to every reader. Its relative the Rough Winkle (*L. rufa*, Maton) is equally abundant, probably often being mistaken for it. This latter species is, however, only half the size of the former, and has a smaller mouth.

The Dwarf Winkle (*L. obtusa*, Linn.) may be recognized by its extremely low spiral, which does not end in a point, and so gives the shell a somewhat globular

appearance. In colour this species ranges from almost black and dark brown to light red, yellow and even white, and since it inhabits the bladder-wrack (*Fucus vesiculosus*) and other weeds of the same group, the darker species may well be mistaken for the air-bladders that characterize these plants. The bright yellow specimens simulate to a remarkable degree the ripe spore receptacles of the knotted wrack (*Ascophyllum nodosum*). It is not altogether certain that this represents a means of protection, however, for the species with its very thick shell is already well protected.

The Nerite Winkle (*L. neritoides*, Linn.) is a very small species that may be found clinging to the rocks, often well above ordinary high-water mark. Undoubtedly the winkles represent a group of marine molluscs that are in the act of leaving the sea for the land, which it is evident that the ancestors of all land shells did at some time or other. Indeed, as already pointed out in these pages, the purely terrestrial Round-mouthed Snail (*Cyclostoma elegans*, Müll.) is a close relative of the winkles, 'from some marine form of which it undoubtedly descended. As a matter of fact, the rough winkle is already well on the way to becoming a land species, since it spends weeks at a time out of reach of the tide.

The empty shells of the pretty little European Cowry (*Cypraea europaea*, Mont.), now usually known scientifically as *Trivia arctica*, Pult., are very common in the sand in the cracks and crannies between the rocks at Penzance. Living specimens are not easy to find, probably because the animal in life keeps just below low-water mark. The adult shell presents a totally different appearance from other British species. There is no sign of a spire, the shell being rounded dorsally, flat ventrally, with a longitudinal

slit for the mouth. As a matter of fact in the young stage the spire and whorls of ordinary univalves are present, but owing to the animal's mantle-flap continually turning upward and enveloping the whole shell, the calcarious matter is so deposited as to hide all semblance in the shell to its original form. In this small species the shell is finely and rather deeply grooved, giving it the appearance of a wrinkled pea, and not highly polished as in all the exotic species, as, for instance, in the money cowry. In colour our species is pale buff, or pinkish, sometimes with dark spots on the back.

The *Muricidæ* are represented in our collection by the well-known Purple, or Dog-Winkle (*Purpura lapillus*, Linn.) and the Sting-winkle (*Ocinebra erinacea*, Linn.). Of these the former is the very common species whose usually whitish, or yellowish-white, somewhat whelk-like shell may be seen all over the rocks between tide-marks. In some cases the white shell is banded with reddish-brown or black. Like all littoral rock-inhabiting species its shell is thick. The spire is pointed and sharp, the mouth somewhat elongate.

The sting-winkle is similar in general shape, but has the shell very heavily ridged and grooved. It is whitish in colour, and occurs numerously on the rocks close to low water.

Of the family *Certhiidæ* we secured specimens of but one species, the Small Needle-whelk (*Bittium reticulatum*, Da Costa). In this species the shell is about half an inch in length, very slender, pointed and rough. Our specimens were found in the sand and gravel amongst the rocks.

Finally, we have the members of the *Nassidæ*, of which the largest and most common is the Netted Dog-Whelk (*Nassa reticulata*, Linn.). In this species

the spire is fairly long and pointed, the whole shell being grooved both with and across the whorls, giving it a netted appearance. It measures about an inch and a quarter in length. It lives in the gravel between the rocks, and its empty shell is brown, the lips being white.

The Dwarf Dog-Whelk (*N. pygmaea*, Lamark) is a very small species abundant upon the weeds in rock-pools near low-water mark. Its shell is of a pale yellowish-white colour, and has a very thick outer lip. The Thick-lipped Dog-Whelk (*N. incrassata*, Ström.), oddly enough, has the lip less thick than the foregoing species, from which it may further be distinguished by its whitish colour spotted with brown, sometimes plain yellowish, pinkish, or even reddish. It occurs in similar places with the foregoing, being more abundant and slightly larger.

